NOISE ELEMENT

of The

ARVIN GENERAL PLAN

Kern County, California

NE 75

1975

NOISE ELEMENT

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City planning Arvin
City " Noise abatement

arvin general plan

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GENERAL PLAN

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16. Abstracts

Goals, policies and standards are established for controlling noise within the city. A procedure for implementing the plan that includes the establishment of an advisory committee is presented. Measuring techniques are described for different types of land uses. Abatement and variance procedures are adopted, and penalty fines are established.

17. Key Words and Document Analysis. 17a. Descriptors

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Environmental Survey (Noise)
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Community Development
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Vibrations
Public Health
Urban Planning
Local Government
Land Use
Planning

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General Plan
Sound Level Analysis
Acceptable Noise Levels
Octave Band Analysis
Environmental Hazards
Acoustic Hazards
Noise Abatement

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"The crescendo of noise--whether it comes from truck or jackhammer, siren or airplane, shatters serenity and can inflict pain. We dare not be complacent about this ever mounting volume of noise. In the years ahead, it can only bring even more discomfort--and worse--to the lives of people."

--Lyndon B. Johnson, 1968

C I T Y O F A R V I N

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BY THE

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We hereby certify that this document, text accompanying tables and maps constitute a Noise Element of the City of Arvin General Plan as required by Section 65302, paragraph (g) of the Government Code, State of California. This "Noise Element," proposed as a part of the General Plan, was reviewed by the Planning Commission; said Commission made its recommendation to this council; this council adopted the Noise Element by Resolution No. 35=75 of the Arvin City Council, at its regular meeting of 25th day of August, 1975, after conducting a public hearing pursuant to Section 65351 of the Government Code, State of California.

Frank Gipson
Mayor
City of Arvin

Ione Collins
City Clerk
City of Arvin

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preface

Effects of Noise

There are a number of ways in which people and their environment are affected by noise. Generally these effects fall into two broad categories: annoyances and damage to health. The difference between these is not always distinct; noises which are annoying may result in eventual physical symptoms such as ulcers, and extremely loud noises are likely to be both annoying and harmful. People react differently to the same noise, largely because of inherent differences between individuals.

The primary health effect of noise is, of course, hearing loss. An estimated 16 million Americans suffer from some degree of hearing loss directly caused by noise. Many of the losses are incurred by employees in industries where high noise levels are present, and compensation payments for such injuries run to millions of dollars each year.[1] In addition to direct damage to hearing from high noise levels, there is another way in which environmental noise endangers hearing. Studies have shown that people require periods of quiet in order to recover from noise overexposure. If the level of environmental noise is too high, this recovery is prevented.

Another important health effect is sleep interference (Figure 1). Noises which cause a person to awaken are annoying as well as detrimental to health. Sleep interference can cause irritability, mental disorganization, dreaming while awake, and other disorders. Noise also can disrupt the normal sleep pattern without awakening the individual, and this interference results in general fatigue.[2] A related problem is dream interference, a subject some psychiatrists have studied. Dr. Julius Buchwald, of the New York State Medical Center, believes that such interference may cause nightmarish memories, paranoidal delusions, hallucinations, suicidal and homicidal tendencies, reduced sense of humor, and inability to handle everyday problems.[3]

Other health effects are referred to as extraauditory physiological effects. These include muscular reflexes ("startle response"), constriction of peripheral blood vessels, changes in respiratory and heart rate, neuro-endocrine system reflexes (including ulcers and other stress reactions), and other neurological responses such as nystagmus (involuntary rapid oscillation of the eyeball) and vertigo. Although definitive research has yet to be done, some recent studies suggest that noise levels may be a factor in the rising rates of heart disease, ulcers, and mental illness, and it may have adverse effects on unborn children.[4]

Noises which are annoying have a number of secondary effects. The most obvious of these is interference with communication. A noise level that is not intense enough to cause hearing damage may still disrupt speech communication or interfere with the enjoyment of music or television. Also, interference with the ability to hear warning shouts or commands increases the probability of accidents.[5] Table 1 shows the effects of noise at various sound levels.

Another of these effects is economic loss due to noise. Speech interference caused by noise may influence commercial sales and reduce work output in jobs where interpersonal communication is important. Noise levels also may interfere with concentration and thus reduce work output in office spaces, particularly in those utilizing the open design concept.

Although it is not always the case, noise levels can affect property values and rentals in some areas, particularly adjacent to airports and heavily travelled highways. Maintaining low noise levels in open space recreation areas, such as campgrounds, parks, and areas of scenic beauty, may be important for the promotion of tourism, which can be of economic value to the county. There also may be economic benefit in maintaining relative quiet in commercial areas, because people will find it more enjoyable to shop in an environment which is not excessively noisy.[6]

Noise can cause certain species of animals, particularly predators, to abandon their habitat. A decrease in predatory species in an area can lead to overpopulation by other nonpredatory herbivorous species which might then propagate to such a level that they would deplete vegetation in the area. Hazards associated with soil erosion are greatly increased as vegetation is depleted.[7]

Livestock also can be adversely affected by noise. Excessive noise has been found to have an adverse effect upon both egg and milk production, and there also is evidence of reduced reproduction in the presence of noise.[8]

PRIMARY EFFECTS OF NOISE

EFFECT	NOISE LEVEL AT WHICH EFFECT OCCURS
HEARING LOSS	75-85 dB(A)
EXTRA-AUDITORY PHYSIOLOGICAL EFFECTS	65 -75 dB(A)
SPEECH INTERFERENCE	50-60 dB(A)
INTERFERENCE WITH SLEEP	35 -45 dB(A)

Table 1

Shown are noise levels which affect various human activities. Levels are expressed in decibels on the A-weighted scale (see Appendix B). A noise of 85 dB(A) is approximately as loud as a Diesel truck, while 45 dB(A) is approximately as loud as bird calls.
Source: Noise Pollution, Hearings Before the Subcommittee on Air and Water Pollution, Committee on Public Works, U.S. Senate, page 313.

The goals of Arvin with regard to noise are to minimize disruption of human activities and conflicts resulting from excessive noise, to protect the economic base of the city, and to protect the public health and welfare. This element contains a description of the noise problem, sets standards for maximum desired noise levels, and suggests a strategy for dealing with noise in Arvin.

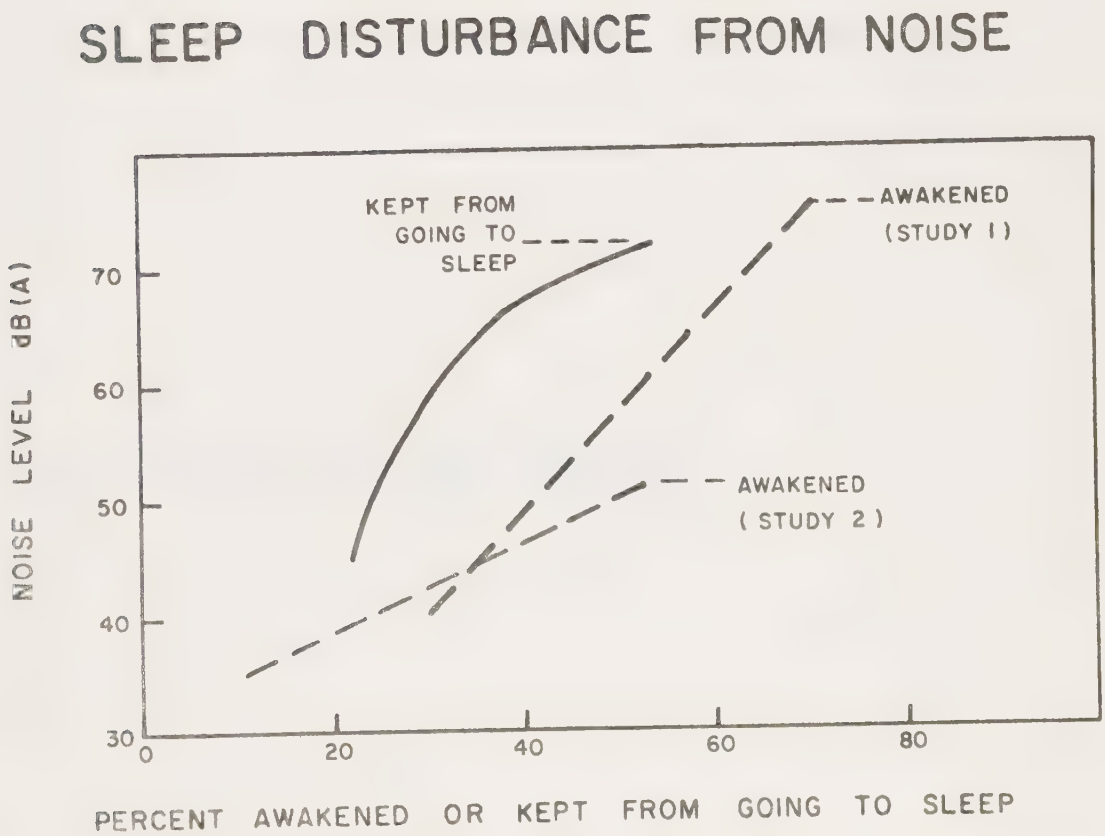


Figure 1

Shown are results of studies of the effects of noise on sleep, with noise levels expressed in decibels on the A-weighted scale (see Appendix B). Noise disturbs sleep in a gradually increasing manner, and 20 percent or more of the population suffers some form of sleep disturbance at 45 dB(A).
Source: Noise Pollution, Hearings Before the Subcommittee on Air and Water Pollution, Committee on Public Works, U.S. Senate, page 305.

introduction

I

INTRODUCTION

Because of its rural character, much of Arvin does not now have a serious noise pollution problem. However, as the city continues to grow and previously undeveloped areas are built up, the noise levels will continually increase. The major goals of this element are to establish reasonable standards for maximum desired noise levels in Arvin and to develop an implementation program which will effectively deal with the noise pollution problem.

A. Mandatory Element

The importance of controlling noise is recognized in the state law, which now lists the noise element as one of the mandatory elements of the General Plan (Government Code Section 65302 (g)). The law requires each local jurisdiction to prepare a statement of policy indicating its intentions regarding noise and noise sources in the community. These jurisdictions also are to establish desired maximum noise levels according to land use category and to set standards for noise emissions from transportation facilities and from fixed-point sources. Each noise element also must contain a program for implementation of noise control measures.

B. Noise Contours

The state law pays particular attention to noise emitted from transportation sources. It requires development of "noise contours" for these sources. Such a contour is a line passing through points where the same sound level prevails, and the contours form bands of varying width indicating sound emanating from a particular source.

This element is designed to present an overview of the noise problem for the layman and to describe the standards, policies, and implementation strategy to be utilized in Arvin. For those desiring more detailed information about the problem, an appendix containing explanations and technical background is included in this report.

summary

II

SUMMARY

GOALS

1. To protect the health of Arvin residents

2. To minimize disruption of human activities and conflicts resulting from excessive noise

3. To protect the economic base of the city

4. To establish reasonable standards for maximum desired noise levels in Arvin.

5. To develop an implementation program which will effectively deal with the noise pollution problem in Arvin.

POLICIES

1. Utilize good land use planning principles to reduce conflicts related to noise emissions

2. Maintain stringent controls over noise emissions from new development

3. Utilize all feasible controls over construction and other temporary noise sources

4. Require reductions in noise from existing sources wherever possible

5. Employ the best available methods of noise control

RECOMMENDATIONS

1. Utilize zoning regulations to assist in achieving noisecompatible land use patterns

2. Require proper acoustical treatment of transportation facilities, including highways, airports, and railroads

3. Establish noise impact zones where new development will be reviewed with respect to noise problems

4. Establish a noise evaluation committee

5. Maintain a noise monitoring program throughout the city

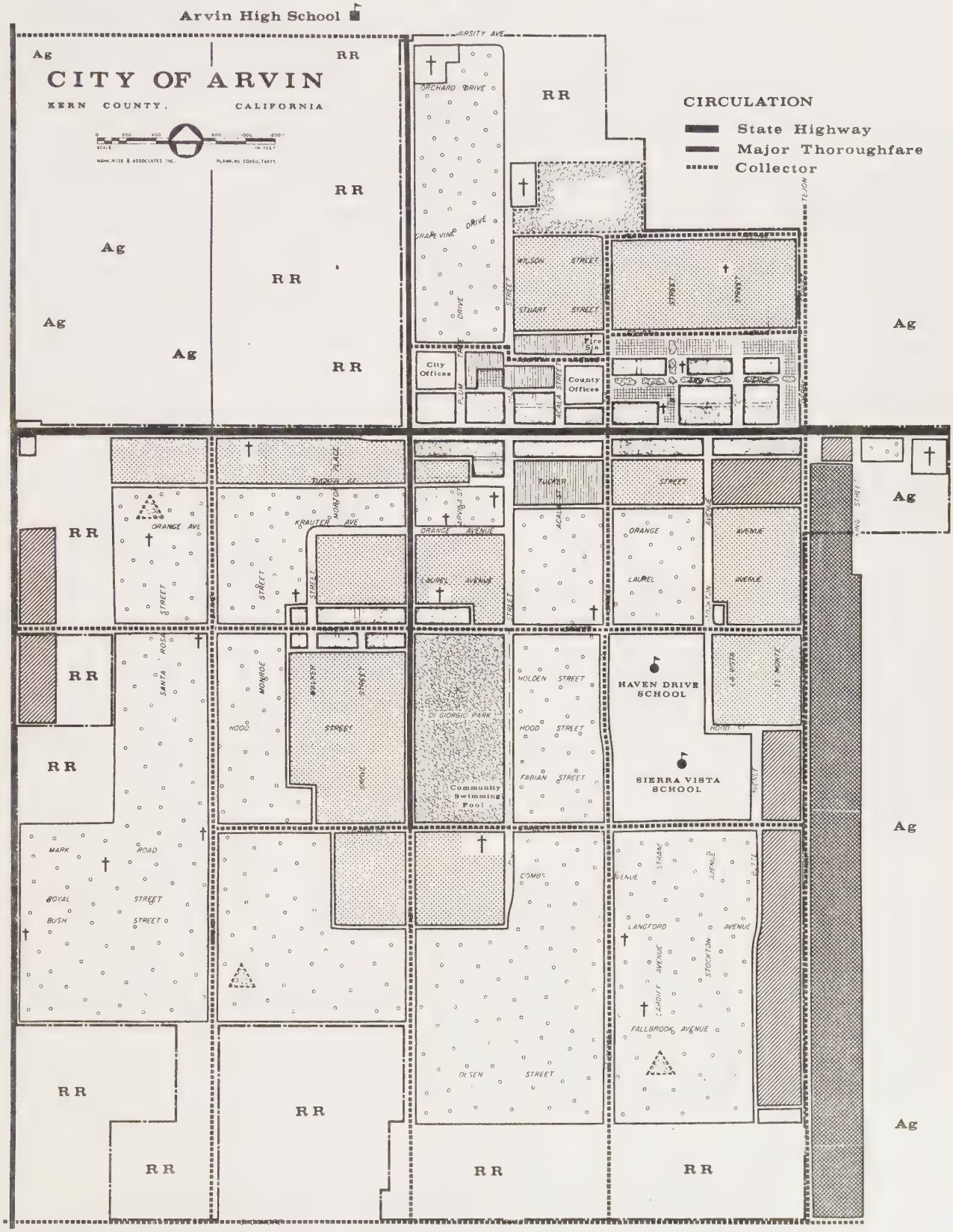
6. Adopt a noise control ordinance for fixed-point sources

7. Develop a public information program with respect to noise and its effects

8. Encourage cooperation between the County and the incorporated cities within the County to control noise

survey of existing noise

GENERAL PLAN



RESIDENTIAL

	Units / Acre
Low Density	4-6
Medium Density	8-12
RR Residential Reserve	

COMMERCIAL

- Retail
- Heavy
- Office
- Shopping Mall

PUBLIC

- High School
- Elementary School
- Existing Park
- Proposed Parks
- Name Other

OTHER

- Industrial
- Ag Agriculture
- Church
- Parking

III

SURVEY OF EXISTING NOISE CONDITIONS

A. Ambient Noise Levels by Land Use Category:

These data will be supplied by the Kern County Health Department prior to December 31, 1975 in accordance with the results of its community noise survey. The survey will be implemented as soon as the required data acquisition system is delivered.

B. Specific Surveys of Problem Areas:

These data will be supplied by the Kern County Health Department prior to December 31, 1975 in accordance with the results of its community noise survey. The survey will be implemented as soon as the required data acquisition system is delivered.

C. Noise Contour Mapping:

1. Airport Noise Contours

Airport noise can be described as a combination of two factors: flight operations and ground operations. Flight operations noise contours for several Kern County airports are being prepared by private consultants as a part of these airports' Master Plans. (The Master Plan is required by the federal government as a condition of federal financial aid.) For those airports which are not preparing these Master Plans, the Kern County Health Department will develop noise contour maps for local planning agencies. All available airport flight operations noise contour maps will be on file at the Kern County Health Department, including those available from the military air bases.

Airport ground operations in Kern County are insignificant in terms of the total noise generation from Kern County airports. Typically, ground operations which may have an effect upon the noise pattern of an airport are jet engine testing, jet aircraft run-ups, etc. The Wyle Laboratories report for the San Diego Comprehensive Planning Organization[9] indicated that such activities comprised an insignificant amount of noise unless their frequency exceeded one per month. No Kern County airports presently schedule such activities, except for the military operations. Available noise contours for the military airports will be on file at the Kern County Health Department.

The noise contours for airports, whenever possible, will be expressed in terms of CNEL levels, and may be compared in Ldn values directly (±1dB). Their use as planning tools will be explained in a following section of this document. Contour maps will be prepared for present and projected (1995) activities.

2. Railway Noise Contours

Railway noise contours will be developed by the Kern County Health Department prior to December 31, 1975 for areas experiencing residential development trends, in accordance with the Wyle Laboratories methodology.[10] Contours may be prepared for both line and yard operations with this metholology. The Health Department will provide assistance in the preparation of additional noise contours, if desired by the local planning agencies.

Railway noise contours will be expressed in terms of CNEL or Lnd, depending upon the data analysis method. Their use as planning tools will be explained in a following section of this document.

3. Roadway Noise Contours

Roadway noise contours will be developed by the Kern County Health Department prior to December 31, 1975 for areas experiencing residential development trends, in accordance with the Wyle Laboratories methodology.[11] These contours will be expressed in terms of Ldn, and their use as planning tools will be explained in a following section of this document. Assistance in the preparation of additional noise contours will be available from the Health Department. Contours will be prepared for present and projected (1995) activities.

Other roadway noise contours, expressed in terms of L_{10} levels, are available from Caltrans. The noise contours developed by the District 9 Caltrans office are presently available at the Kern County Health Department. It is not known whether the District 6 Caltrans office will supply L_{10} contours for Kern County. As far as interpretation of these L_{10} contours for traffic noise is concerned, they may be considered as being roughly equivalent to an L_{dn} value plus 3 decibels, i.e., $L_{10} = L_{dn} + 3$, dB. These contours may be used as an indicator of public annoyance due to traffic noise, particularly where diesel trucks are present.

4. Miscellaneous Noise Source Contours

Miscellaneous noise sources which are significant in terms of public reaction which would require particular attention in regard to adjacent land use planning will be mapped in terms of L_{dn} noise contours. The contours will be established in accordance with the results of field surveys and determinations made by the Kern County Health Department.

standards for land use

IV

STANDARDS FOR LAND USE

A. Application of Ambient Noise Level Standards

Ambient noise level standards are established to provide goals for land use planning which will ensure the compatibility of various land uses with respect to environmental noise. Such standards will be used as tools for judging the impact of the noise environment upon a proposed development, as well as the impact of noise created by the development with respect to neighboring properties. In addition, ambient noise standards will be used to judge the effectiveness of the planning process and community noise control measures by comparing them to community noise monitoring results obtained over a period of several years. The principles served by the noise element standards are primarily that (1) noncompatible land uses should be separated, (2) land uses should be conducive to public enjoyment of the environment, (3) public exposure to excessive noise should be minimized, and (4) that the environment should not be degraded by excessive noise.

New land use proposals should be compared to the ambient noise level standards to determine if the project is compatible with the existing noise environment. If the project is found to be incompatible in terms of those standards, the developer may be required to provide noise control measures such as barriets, additional insulation, etc. If the noise standards cannot be stisfied by any means, disapproval of the project will be considered.

The following ambient noise level standards have been developed for this noise element. They are based upon the findings of the California State Department of Health, the U.S. Environmental Protection Agency, and noise control ordinances presently in use in California. They are also comparable to the California State airport regulations and HUD guidelines. (See Table 2).

The noise level standards are designated for four (4) basic land use categories. The first category of land uses is described as relatively "insensitive." This classification includes an unusually wide variety of land use activities, public utilities, transportation systems and other noise-related uses. The second category of land uses is described as "moderately sensitive," and includes general business and recreational uses. The third category is described as "sensitive" and consists basically of residential uses. The fourth and last category is described as "highly sensitive," and includes hospitals, schools, convalescent homes, churches, etc. The various major land uses within these four categories are listed in Table 3. Certain land uses may not be listed; such uses should be placed in the category containing the most comparable listed use.

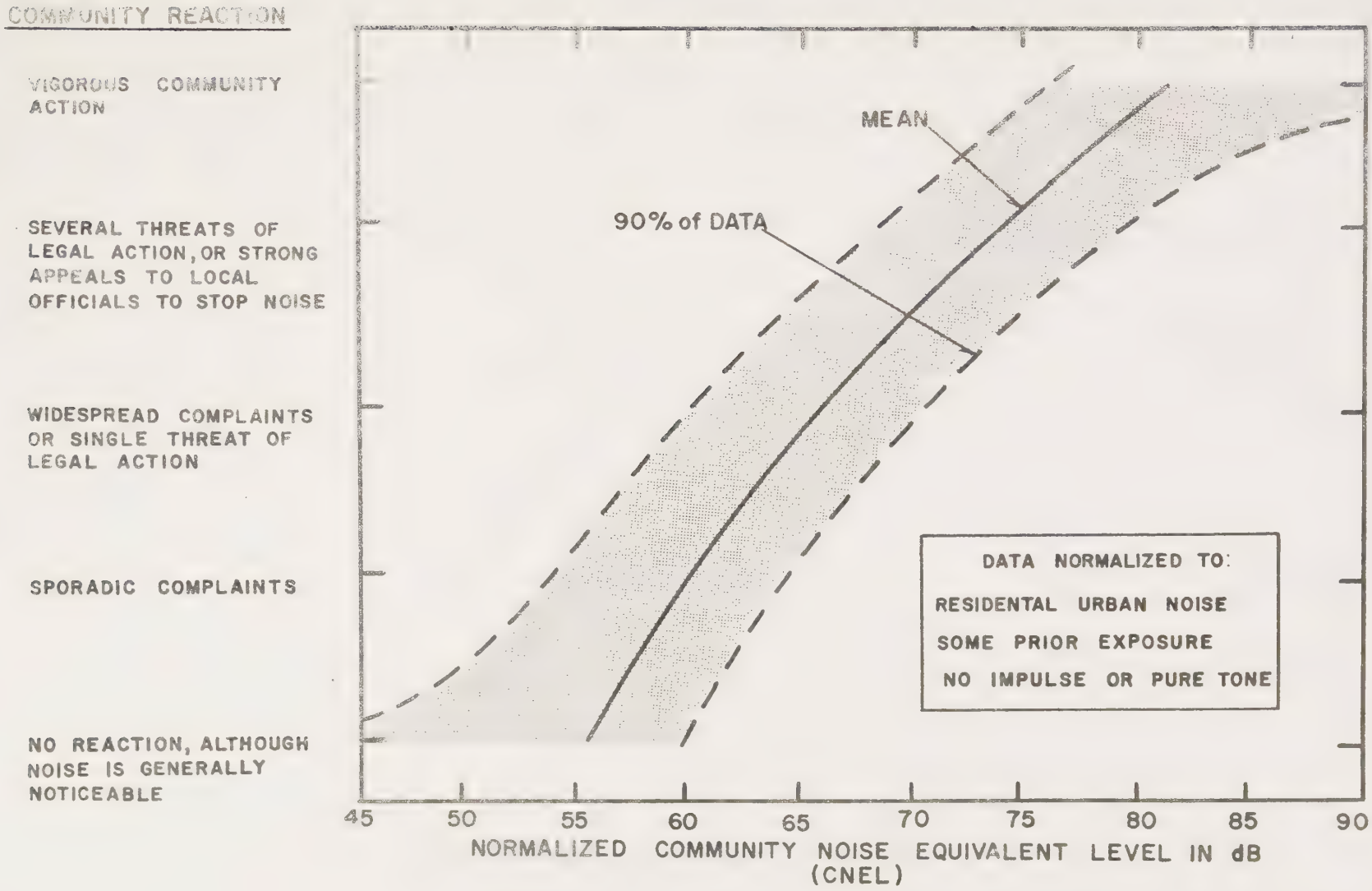
The noise level standards have been expressed in terms of ambient noise levels and L_{dn} or CNEL values to allow a simple field check of a potential land use site with a relatively inexpensive, hand-held sound level meter (for ambient levels), as well as to allow a more comprehensive review of

the site with more sophisticated sound level measuring equipment (for L_{dn} and CNEL), while allowing comparison with the noise contour maps prepared for this element. For an intensive review of a major project, CNEL or L_{dn} values shall be determined for the site and compared with these standards, EPA recommendations, and the provisions of California Administrative Code Section 1092 and the 1973 Uniform Building Code, if adopted. For general use, or where the data suggest that the above standards may be easily satisified, no further analysis is necessary.

TABLE 2

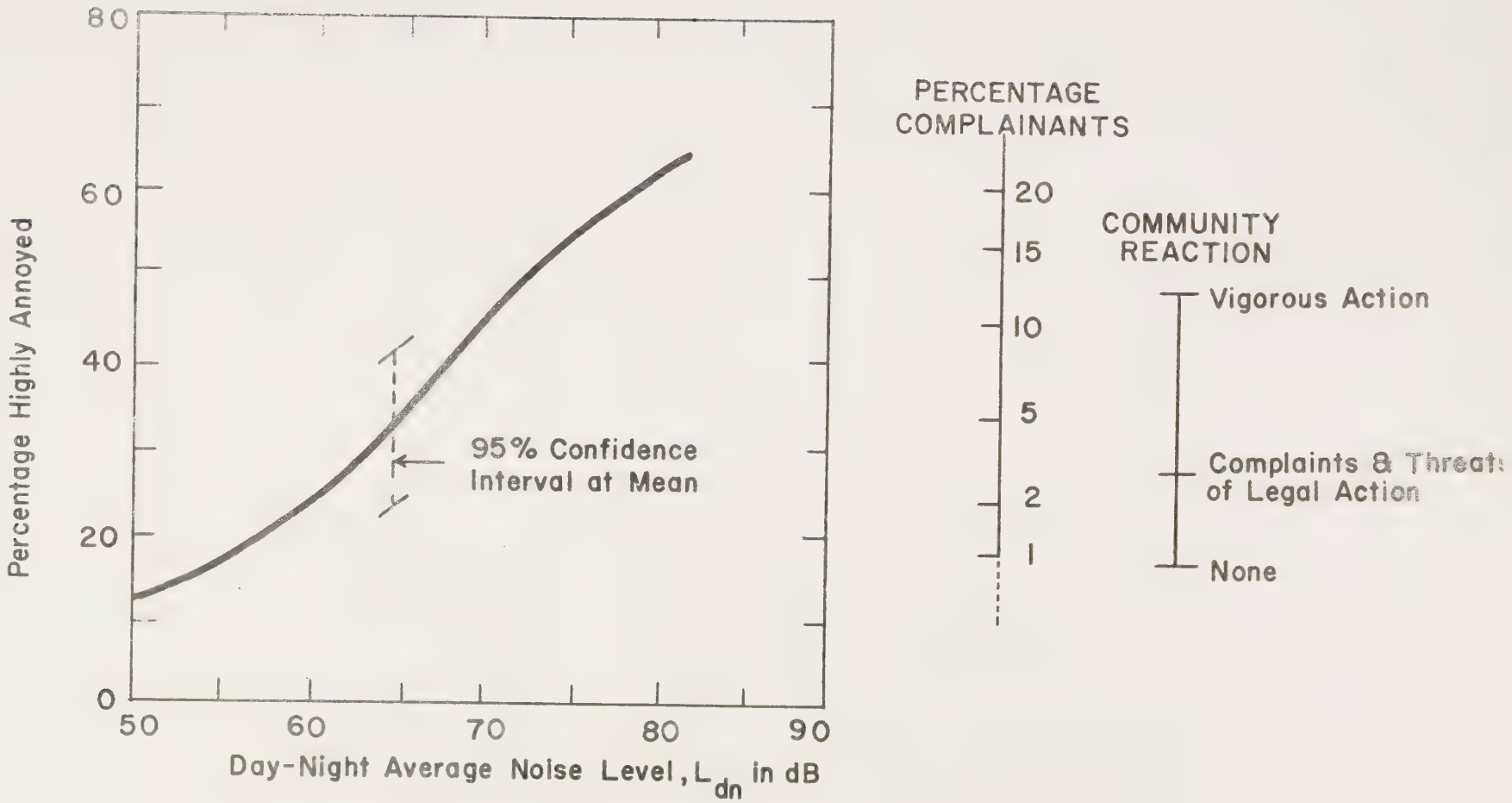
NOISE LEVEL STANDARDS			
Land Use Category	Ambient* Noise Levels (L_{50}) in dB(A)		L_{dn} or CNEL Equivalent
	Day (0701-2200)	Night (2201-0700)	
"Highly Sensitive" Land Uses	45	35	50
"Sensitive" Land Uses	50	40	55
"Moderately Sensitive" Land Uses	55	50	65
"Insensitive" Land Uses	60	55	70

*Ambient Noise Level is defined as the all-encompassing noise associated with a given environment, being usually a composite of sounds from many sources near and far. For the purposes of this element, ambient noise level is the level obtained when the noise level is averaged over a period of 15 minutes or some other predetermined time interval, without the inclusion of noise from isolated identifiable sources. In this element, the L_{50} level is used as a comparative index of the ambient noise levels.



SOURCE: REPORT TO THE PRESIDENT AND CONGRESS ON NOISE
FEBRUARY 1972

FIGURE 2



Intercomparison of Various Measures of Individual Annoyance and Community Reaction as A Function of the Day-Night Average Noise Level, L_{dn} in Decibels.

SOURCE: EPA Task Force 3, NTID 73.4 7/27/73

FIGURE 2A

TABLE

LAND USE CATEGORIES BY MAJOR LAND USE ACTIVITIES

"Insensitive" Land Uses:

Agriculture
Horticulture
Livestock Farms
Forestry
Mining and Extraction
Water Areas
Natural Open Space
Undeveloped Land
Railways and Terminals
Transit Systems and Terminals
Auto Parking
Raceways and Drag Strips
Motorcycle Parks
Rifle Ranges
Liquid and Solid Waste Facilities
Industrial Manufacturing
Warehousing Utilities
Wrecking and Salvage Yards
Construction Yards

"Sensitive" Land Uses:

Single Family (Detached) Dwellings
Single Family (Attached) Dwellings
Multi-Family (Low Rise) Dwellings
Multi-Family (Mid Rise) Dwellings
Multi-Family (High Rise) Dwellings
Dormitories
Resort Hotels
Out Patient Clinics
Pre-Schools
Mobilehome Parks
Motor Inns
Hotels
Cemeteries
Professional Research

"Moderately Sensitive" Land Uses:

Country Clubs
Athletic Clubs
Golf Courses and Driving Ranges
Tennis Clubs
Equestrian Clubs
Scientific Testing
Government Services
Lodges, Community Associations
Restaurants & Bars
General Merchandising
Professional Offices
Recreation Vehicle Parks

"Highly Sensitive" Land Uses:

Single Family (Detached) Dwellings (Rural)
Educational Facilities
Hospitals
Convalescent Homes
Auditoriums, Concert Halls
Wild Life Sanctuaries
Churches

Provisions should also be made in the planning process for the review of projects with regard to any noise control ordinances which the local jurisdiction may enact in the future. In certain cases, standards based upon such ordinances may be more useful than the following table.

Figures 2 and 2A allow comparison of the noise element standards to expected community response in residential areas.

The avove factors point out what appears to be an anomaly in the use of the standards namely that, up to a point, it is acceptable to expose a greater number of people to a greater noise level, while fewer people are exposed to lower noise levels. This apparent contradiction can be explained by the fact that the CNEL 55-60 range is not a highly objectionable noise environment; in fact, it is within the acceptable limits proposed by the U.S. Environmental Protection Agency for residential use. Lower noise level categories (suburban and rural land uses) intended to result in an improvement over the urban noise environment, consistent with those noise levels which people expect and desire of such environments. An intrusion of rural land uses into a noise environment more acceptable to urban residents is thus not necessarily unacceptable from a public health or annoyance standpoint, but is not keeping with the aesthetic objectives of such a use.

Table 3 illustrates the application of the noise element standards to various land uses. Note that open-space land uses such as the O-S, A, and NR zones are considered compatible with any noise environment. This should not be construed to imply that such zones are "free noise" zones, but only that anticipated land uses within those zones will be relatively insensitive to environmental noise.

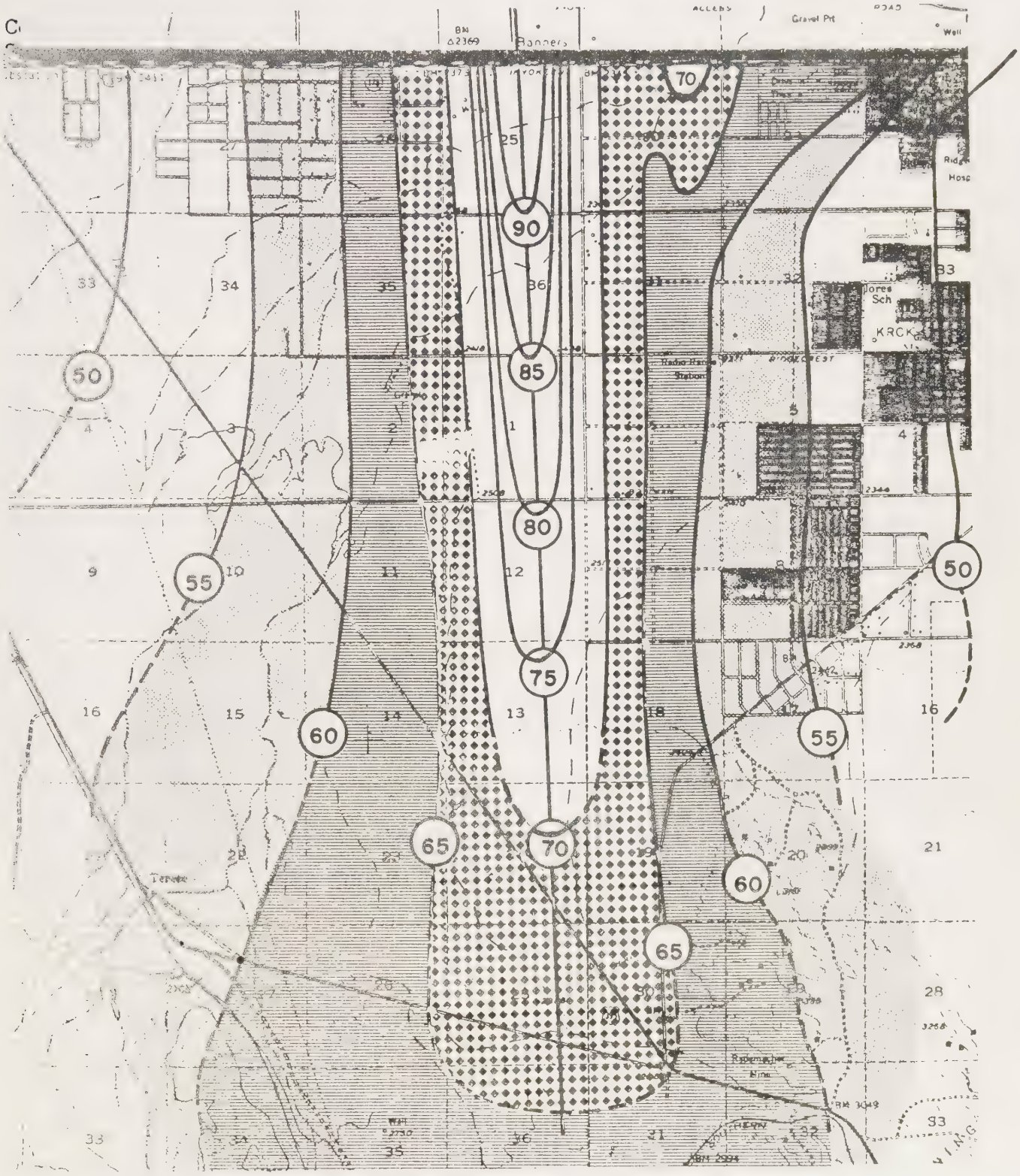
B. Application of Noise Contours

Values represented by noise contours should be wighed in accordance with the provisions of the noise standards of this element and the provisions of the California Administrative Code, Title 25, Section 1092. In addition, the recommendations contained in forthcoming EPA studies should be considered. Each of these guidelines may be related to CNEL or L_{dn} values. The principles expressed thereby should be applied to all other similarly identifiable noise environments (See Figure 10).

An example of the application of noise level contours is given by Figure 3. In this situation, involving an area near the City of Ridgecrest, aircraft noise level contours were developed. The following analysis and recommendations could be applied equally well to noise level contours generated by roadways, railroads, or any other major noise source.

These composite CNEL contours should be considered in land use planning for the Ridgecrest area. Specifically, land use within the area encompassed by the solid contour lines should be governed by the goals of achieving the standards of this element. For example, land within the CNEL 55 and 60 dB contours would be considered suitable for urban development, but not suitable for suburban residential uses.

COMPOSITE COMMUNITY NOISE EQUIVALENT LEVEL CONTOURS, RIDGECREST AREA



ADAPTED FROM: SURVEY AND EVALUATION OF THE ENVIRONMENTAL IMPACT OF NAVAL WEAPONS CENTER ACTIVITIES, NWC TECHNICAL MEMORANDUM 2426, JUNE 1974

LEGEND

Suitable for industrial uses

Suitable for commercial uses

Suitable for residential (multiple-occupancy) uses

FIGURE 3

Comparison of the standards would be compatible with the EPA findings. Similarly, the HUD recommendations contained in Aircraft Noise Impact-Planning Guidelines for Local Agencies (TE/NA 472), when converted to CNEL equivalency as shown in Figure 10, would indicate that uses stipulated by the standards are "clearly acceptable." California's airport noise regulations (California Administrative Code, Title 4, Sections 5000-5080) would apply similar, though more lenient standards to land use surrounding airports operating under permit with the Department of Aeronautics. In that the Naval Weapons Center is a federal Facility, the California regulations are not applicable. It is also important to note the California airport noise regulations establish a criterion noise level, rather than a goal for future land use planning.

It would be recommended that land use in the area encompassed by the solid and dotted lines of the contour intervals on Figure 3, be guided by the noise element standards, as shown on that figure. Equivalent land uses may be determined by comparison to Figure 10. For those areas South of the CNEL 70 dB contour line (with the exception of that included in the CNEL 65 dB contour line), bounded on the South and West by the Southern Pacific Railroad and on the East by the line formed by the west boundary of Section 21, T27S, R40E; it would be recommended that land use proposals be subject to acoustical analysis to determine CNEL contours for specific property proposed for developments unless such a determination had been previously made. Land use in this area should also be guided by the noise element standards.

It is important to realize that noise contours do not comprise distinct boundaries between specific noise levels. They should be treated as the empirical devices that they are, based upon data collected from "typical" sources and applied to "typical" situations. Noise contours are useful tools when considered to be zones of influence and indicators of where specific studies should be conducted. It is most practical and useful from a planning viewpoint to let noise contours dictate where a project should be subject to further acoustical analysis. After sufficient acoustical study has been devoted to the development site, the relevancy of state laws, the noise element standards, and other guidelines may be determined.

implementation

V

IMPLEMENTATION

To be of value in shaping and controlling the noise environment in the local jurisdiction, the Noise Element must provide a successful implementation program. The general policies suggested can be achieved through a cooperative effort between governmental agencies and private individuals and agencies. It is to that end that the implementation program is instituted.

To be effective the procedures set forth require concentrated efforts by the Kern County Health Department and the city. In addition, a forum for discussion, evaluation and recommendation on noise-related problems should be provided.

Adoption of a Noise Control Ordinance for fixed-point sources: The Health Department, utilizing the information from its noise survey, will develop a proposed community noise control ordinance. The recommendations of the Health Department will be submitted to the Noise Evaluation Committee for review. Upon recommendation of the committee, the City Council will consider the ordinance for adoption.

Coordinate the city's noise control program with that of other incorporated cities and the County of Kern: Noise does not stop at the boundary lines between jurisdictions. To achieve complete control to community noise, the county and cities must work together.

Provide information on noise and its control to the public: Public awareness that unwanted sound can be controlled through the joint efforts of citizens, government and private industry, is the greatest force behind an effective noise control program. The Planning Commission and City Administrator will be responsible for development and dissemination of the information to the public.

Maximum acceptable ambient noise levels have been developed to provide a measurement of the noise environment within the city and adjacent county areas. The levels may be used to evaluate the effectiveness of noise control plans or to determine the noise impact of a proposed project. Therefore, the City Administrator will channel the information to the appropriate department for uses in the control abatement program.

Monitor the community noise environment: The Kern County Health Department will prepare a prediction model for monitoring the community noise pattern through a random spot check.

Evaluation of proposed project sites: All future development project sites will be evaluated by the Health Department at the request of the City Council to determine the noise environmental impact on the proposed project. Where the study indicates a potential problem exists, the Kern County Health Department may be requested to conduct a detailed investigation of the site.

Upon completion of the impact study, the Planning Commission will make recommendations to the decision making body regarding the suitability of the site, secondary methods of sound control or other mitigating measures.

The California Administrative Code, Title 25, Section 1092 establishes certain noise insulation standards for multiple occupancy dwellings. Adoption by the city of Chapter 35 of the 1973 Uniform Building Code will help to reduce noise levels within single-family residences through insulation standards for interior walls. The city will supplement the U.B.C. by adoption of a local ordinance establishing insulation standards for exterior walls of single-family dwellings which will be similar in provisions to Section 1092 of the California Administrative Code, Title 25.

A. Methods for Achieving Noise Reduction

There are two types of sound transmission: direct and reflected. The first is transmitted directly to the ear from the source. The second is a result of sound reflection off surfaces, walls, floors, ceilings, etc.

There are several methods of noise control. They include:

- quieting the noise source itself
- Substituting noisy operations with quieter operations
- buffering or enclosing the source
- controlling the operation or location of noise sources
- absorbing reflected sound
- masking the noise
- insulating the receiver

Quieting the source of noise is the best solution when feasible. This can often be done by using better mufflers, by replacing metal parts of machines with plastic parts, by lining machines with insulation to absorb sound, by isolating machine vibration, and through proper maintenance of equipment including lubrication, balancing, and tightening of loose parts. Replacing old equipment with quieter models, and replacing noisy operations with quieter ones which accomplish the same end, are other possibilities.

It is not always expedient or feasible to quiet a source of noise. It may often be possible to mitigate the effect by the use of buffers or enclose the noise source. This can be accomplished with solid barriers (such as concrete freeway barriers), with partial or total enclosure of a machine in a room or building, or with sound absorbing materials draped over machines. Distance can also be used as a buffer.

Controlling the operation or location or noise sources is another possibility. For example, setting curfews or time limits, establishing land use zones, setting performance standards or route restrictions, etc., will help to eliminate noise problems in many situations.

Reduction of reflected sound can be accomplished by absorption, with soft, or porous materials. Carpets (the thicker the better, and with good padding) and absorptive walls and ceilings (cork, acoustic tile, heavy drapes, unpainted concrete block) will help deaden the sound in a room. They will <u>not</u> reduce the noise level coming from any source, but they will reduce the reverberation time so that the sounds do not continue to echo.

"Masking" is a further type of sound control which is sometimes used in offices or restaurants to block out objectionable sounds and to provide a measure of privacy. A soothing sound is pipe in, such as music or in some instances air conditioning, which covers up distracting sounds and at the same time makes it more difficult for those farther away to understand what is being said.

Insulating the receiver is often a last resort, where economics, or the state-of-the-art of available methods make it impossible to achieve better work or residential situations. Good contruction techniques and insulating materials, and ultimately, personal ear protection, will help insulate persons from noise sources.

In most instances, the key to quiet is in the planning, layout, and design of a project whether it is a building, a subdivision, or of a city. Once construction has occurred, it is usually much more expensive and difficult to achieve satisfactory results. Excellent results can be achieved, often at little to no added expense if noise considerations are taken into account at the beginning.

The following section deals with methods of alleviating existing bothersome noise situations, and methods of designing to prevent problem noise situations from occurring in the future.

B. The Planning Function and Noise

1. Comprehensive Planning

A broad planning philosophy insists no problem should be ignored if it is influential upon the functioning of the city. The future noise environment is influenced by local controls and policies. The planning function should project and program the future level of noise within the local jurisdiction. Design of a comprehensive transportation system should consider noise impact in policy decisions regarding mode selection.

2. Noise-Impacted Areas

Noise-impacted areas may be identified by comparison of the project site with the noise contours for transportation facilities developed by the Kern County Health Department. In these areas, roughly delineated by the 55 dB L_{dn} noise contour, site plan review will be required prior to project approval. It is important to note that the noise contour boundaries do not represent fixed lines, but rather indicate general areas of noise impact. Development within these areas would be reviewed with respect to the existing noise environment, the noise quality standards, and the projected noise environment upon completion of the proposed project. Noise contours are shown in increments of 5 dB L_{dn} and are continued down to 55 dB L_{dn} wherever possible. The state guidelines require continuing the contours to 45 dB(A) in areas including hospitals, rest homes, long-term medical or mental care facilities, or outdoor recreational areas. From a practical standpoint, this requirement cannot be met, but these areas will be monitored by the Kern County Health Department. (In some cases there is no contour as low as 45 dB (A), since carrying the contours to this extent results in interference from secondary sources, such as traffic on local streets).

3. Practical Limitations

In reality, the planning function is more limited in scope than the policing of a Community Noise Control Program, both because of subject emphasis and administrative functions and authority of the Planning Department. The following restraints show that many manifestations of the noise problem require an interdisciplinary approach, such as an interdisciplinary project team or a study committee of department heads or citizen representatives:

(a) Planning department staff time is usually oriented more toward preventing possible nuisances through land use planning, rather than abating existing nuisance conditions.

(b) Planning departments do not usually have the mobile and extensive enforement staffs which other agencies may have.

(c) Many noise problems are within defined categories of responsibility outside the scope of the Planning Department, such as the responsibility of the Building and Safety Department for the internal characteristics of a structure.

C. Noise and Physical Planning Devices

1. Transportation Planning

a. Magnitude. Noise from transportation sources is the major source of urban noise. Street and highway noise immediately affects each individual, since roadways extend throughout the city.

Street noise is a major contributor to the ambient noise environment. The noise generally is emitted from automobiles and trucks, with truck noise having a substantially higher proportional impact. On more local streets where there are no trucks, passenger car noise predominates. Street noise can have significant effects on humans, can be insidious in its intrusion, and is often unrecognized. The levels of street noise will be indicated on noise contours developed by Kern County Health Department, and can be compared to the standards set forth in this element to indicate potential levels of detrimental impact.

b. General Application. Noise implications are involved throughout transportation planning. Noise generation has been implicit in past transportation planning, but without the more intensive analysis possible today. Noise implications can be considered in route selection, in design considerations such as roadway widths, grades, elevation, buffering setbacks, and in routing of trucks and cars once the highway is completed. Common design concepts consider noise, as in the protection of residential areas from arterial traffic or separation of vehicle and pedestrian traffic in a shopping mall. Common zoning practice considers street noise in use of certain zones or parking areas as "buffers."

A detailed noise analysis can be made for any new route according to a procedure similar to the following, which is adapted from Department of Transportation policies and procedures:

(1) Predict noise generation for alternate routes;

(2) Identify affected land uses or activities;

(3) Determine existing noise levels for land uses and activities;

(4) Compare generated and existing noise levels to determine impact.

(5) Evaluate noise abatement measures to reduce or eliminate noise impact for developed lands;

(6) Identify where exception to design noise levels is needed and prepare recommendations.[12]

c. Barriers. A common result of evaluation such as the above is the requirements of a wall, berm, or other solid barrier (See Figure 4). Requirement of barriers often is necessary because increasing separation distance from the source is often difficult and expensive and many streets are existing or committed in relation to land uses.

The State of California has conducted limited experiments in barrier construction. Some examples can be observed in use along the San Bernardino Freeway. Construction of barriers by local government may be more difficult because of high costs, limited right-of-way widths, and interference with visibility of merchants.

The "barrier adjustment factor" involves a series of trade-offs which can be also imposed on private development. For example, a wall of ten feet height could lessen sound propagation by the equivalent of moving the observer five times further away from the noise source. Attenuation by distance alone can be expensive because the distance in which development is not allowed can be rather large. This "noise setback area" could only be used for streets, landscaping, pedestrian ways, and the like. It is expected that a developer would favor use of walls and berms to gain the most effective use of his land, rather than use an extensive "noise setback area."

The effectiveness of a wall or berm can be estimated by a series of interrelated charts found in the HUB Noise Assessment Guidelines. Utilizing these interrelated charts, the sound attenuating characteristics of a barrier can be calculated in each individual case according to distance between site and barrier, distance between site and barrier, distance between barrier and source, elevation of source, and elevation of barrier. These characteristics vary for each site and each location on the site (assuming the source noise does not vary). A separate noise estimation process must be undertaken each time noise is considered.

SOURCE: BEATON AND BOURGET, OP. CIT., FOOTNOTE 20.

AN AESTHESTIC CONCEPT OF A NOISE SHIELD NEAR RESIDENCES IN FLAT TERRAIN

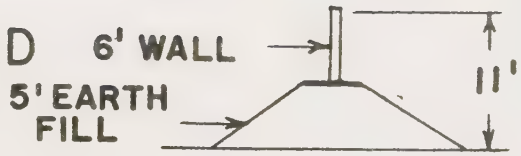


FIGURE 4

More detailed techniques are also available, such as found in the Noise Assessment Guidelines Technical Background by Bolt, Beranek and Newman, Inc., or the Highway Research Board's Highway Noise-A Design Guide for Highway Engineers.

d.. Highway Noise. To provide adequate safeguards from the noise generated by highway traffic, future rights-of-way for major highways should be excluded from residential development. For those cases where it becomes necessary to traverse residential areas, the following measures should be utilized.

The roadway should be depressed 15 to 20 feet below the surrounding grade. An earth berm 10 feet higher than grade would be placed at the depression edge. An acoustical barrier with an effective height of 25 to 30 feet would be provided. Beyond the pavement, the right-of-way would extend to 200 feet and be maintained as a permanent greenbelt. For an illustration of this freeway configuration, see Figure 5. The noise reduction which could expected from such a configuration would be 15 dB (A) over the sound level of a freeway at grade with no acoustical treatment.

Existing highway systems which have an extremely high impact on residential areas should be acoustically treated to reduce the noise levels. An 11 dB(A) reduction could be expected for freeways at grade where an 11-foot barrier is used. By dividing the barrier into a 5-foot earth fill and a 6-foot wall, a more aesthetically pleasing barrier can be built.[13] (See Figure 4).

Elevated freeways provide a 3- to 6-decibel reduction in sound level over an at-grade roadway. To provide an additional 9- to 12-decibel reductiom, an 8-foot solid barrier can be constructed along the pavement edge.[14] (See Figure 6).

The above acoustical treatments provide reduced noise levels along freeway sections except for entrance and exit corridors. The limitations of this approach are recognized, as openings through any sound barrier will exist to permit access to and from the freeway. Nevertheless, where freeways traverse highly sensitive areas, exit and entrance corridors should be acoustically treated in a similar manner to provide the maximum possible shielding from highway noise.

e. Railroad Noise. Noise from passing trains is a problem similar to street noise. It contrasts, however, in that occurrences are less frequent, but each occurrence is quite loud. A rough criterion for use in attenuating train noise is to eliminate line-of-sight exposure as developed in the HYD Noise Assessment Guidelines. More detailed estimation of the barrier adjustment factor can be done using the techniques applied to highway noise. Treatment of railroad noise problems may be accomplished by performance standards, acoustical treatment, or relocation of activities.

FREEWAY CONSTRUCTION THROUGH RESIDENTIAL AREAS

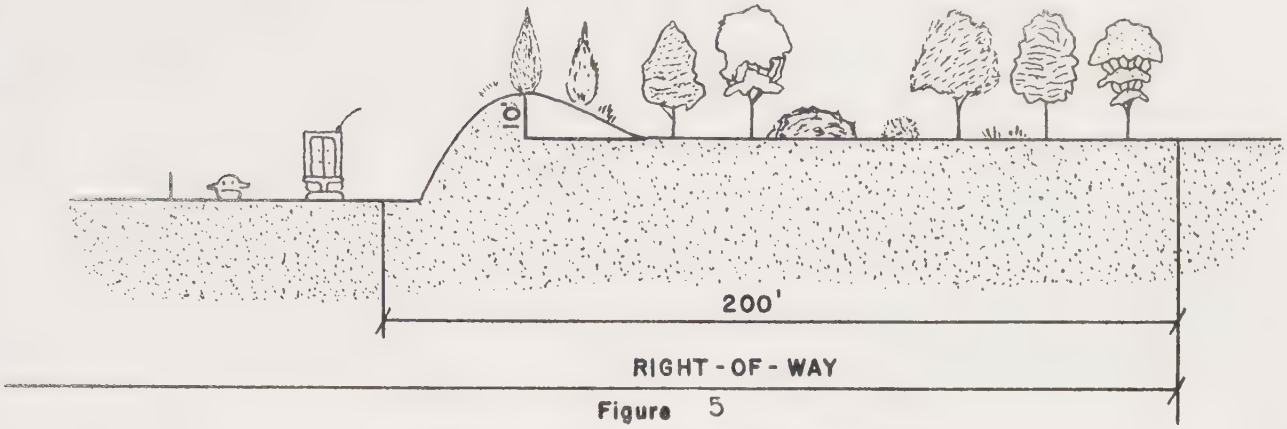
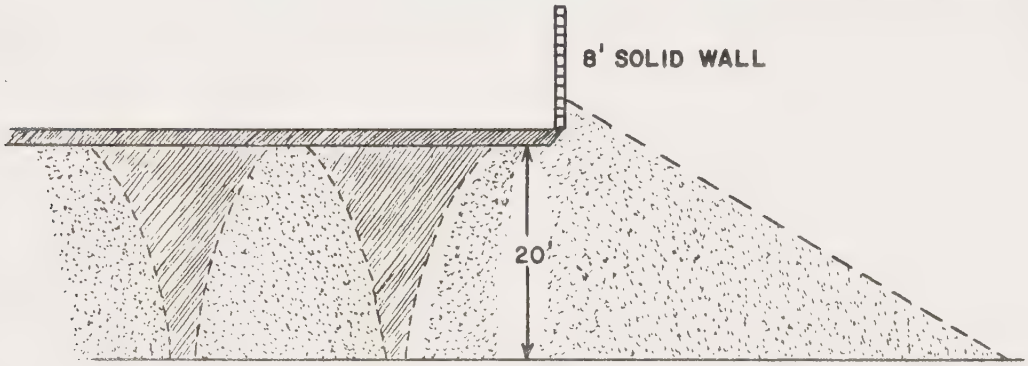


Figure 5
SOURCE: Kern County Planning Commission

ACOUSTICAL TREATMENT
FOR STRUCTURED OR EARTH
FILL ELEVATED FREEWAY

Figure 6
SOURCE: Kern County Planning Commission



SOUND BARRIER FOR
RAILROAD LINE OPERATIONS

Figure 7
SOURCE: Kern County Planning Commission

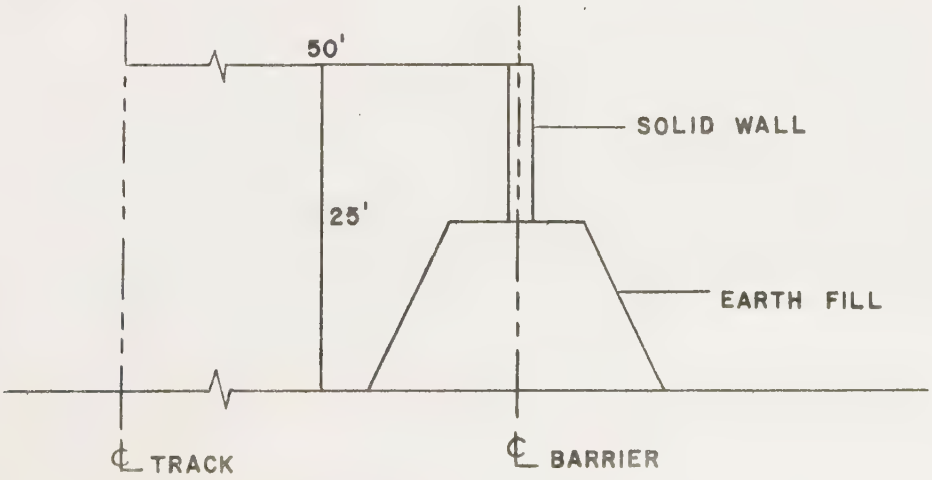


FIGURE 5, 6, & 7

Operational practices should be critically reviewed by the railroad companies as related to night-time activities. All operations between the hours of 10:00 P.M. and 7:00 A.M. should be limited near concentrated residential development. Such a review can be accomplished in a relatively short period of time and can be maintained as a continuing process.

Critical impact points along line operations and near yard activities should be acoustically treated to provide a sound barrier between the source and the receiver. Figure 7 shows an acceptable method of providing approximately a 20 dB reduction in the noise produced by wheel/rail interaction and a 12 dB reduction in noise from locomotives, as measured at distances greater than 200 feet from a noise barrier.[15]

Similar methods can be applied to yard activities to reduce the noise levels received by residential communities. Sound barriers located strategically throughout and at the perimeter of railroad yards can substantially reduce the noise levels.

Acoustical treatment of railroad activities is a medium-range goal. Detailed studies and coordination between the railroad companies and the local planning agency are necessary to determine priorities for installation of acoustical barriers. Furthermore, budgeting for capital outlays and construction requires additional time constraints.

Ultimately, relocation of yard activities away from residential communities may be the only method to insure relief from noise pollution associated with yard operations. Relocation is an extreme step and will require detailed planning to accomplish. It is necessary that the local planning agency work closely with the railroad companies to insure that all other methods for noise control have been utilized. Only where other methods fail to reduce noise levels to acceptable standards will relocation become necessary. Therefore, relocation of yard activities is a longrange goal to be obtained only if necessary in the future.

Zoning Decisions

a. General Concept. Zoning and rezoning decisions have implicitly considered noise impact in the allocation and segregation of land uses. As with traffic noise, more detailed analysis and monitoring is possible today.

b. Buffering. The use of zones as buffers is an example of this inherent noise consideration. A common approach is to locate commercial areas along arterials to cushion the affect of noise on residences. Both distance and sound deadening and reflection are involved. However, this approach runs contrary to present practices of making retail areas more compact and clustered, off the roadways, rather than retaining the strip-commercial type of development favored in the past. Where strip developments are discouraged along arterials, it is likely that noise attenuation devices will be needed for adjoining residential areas.

Avoid Building Sites At Intersections Of Major Traffic Arteries. Such Sites Are Extremely Noisy Due To Accelerating, Decelerating, And Braking Vehicles.

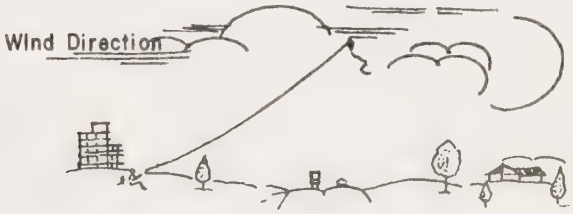
BUILDING SITES NEAR TRAFFIC JUNCTIONS.

Avoid Building Sites On The Crests Of Hilly Traffic Arteries. Such Sites Are Very Noisy Due To Low Gear Acceleration Noise.

BUILDING SITES Near HILLY TRAFFIC AREAS.

Use of Various Noise Barriers.

Use of Building as Noise Barriers.



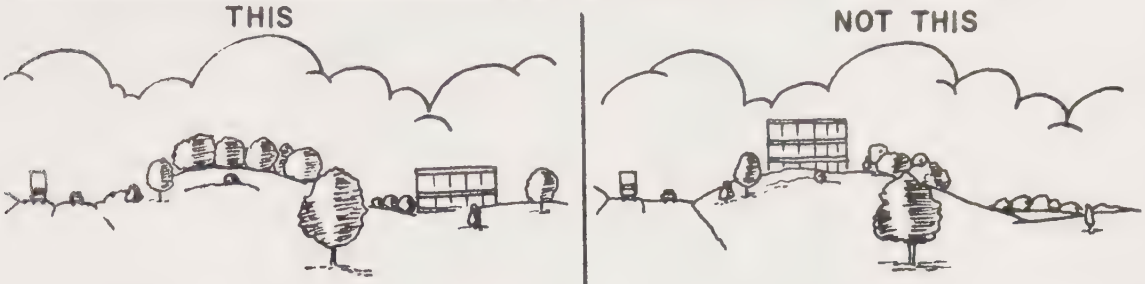
Upwind Building Site is Less Noisy Than A Downwind.

SELECTION OF BUILDING SITES RELATIVE TO WIND DIRECTION.

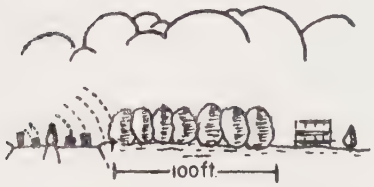
FIGURE 8

SITE SELECTION CRITERIA FOR NOISE MITIGATION

SOURCE: RAYMOND D. BERENDT, GEORGE E. WINZER AND COURTNEY E. BURROUGHS OF NATIONAL BUREAU OF STANDARDS FOR FEDERAL HOUSING ADMINISTRATION, A GUIDE TO AIRBORNE, IMPACT, AND STRUCTURE BORNE NOISE — CONTROL IN MULTIPLE FAMILY DWELLINGS, (WASHINGTON: USGPO, SEPTEMBER, 1967), pp. 5-1 and 5-2.

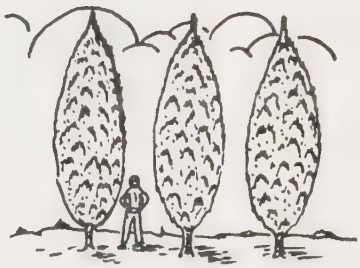


Use of Natural Noise Barriers.



a thick growth of leafy trees & underbrush reduces noise about 6 to 7 dB./100 ft. (average over audible freq. range)
low freq. loss: 3-4 dB
high freq. loss: 10-12 dB

EFFECTIVENESS OF WOODED AREAS AS NOISE BARRIERS.



High Freq. Reduction 3-4 dB
single row of trees is worthless as noise barrier. due to inter-reflection multi-rows of trees are more effective.

NOISE REDUCTION OF TREES.

avoid hollow or depressions they are generally noisier than flat open land.

AN EXAMPLE OF A POOR BUILDING SITE.

building sites in open areas are less noisy than sites in congested building areas.

traffic arteries between tall buildings are quite noisy.

BUILDING SITES NEAR TRAFFIC ARTERIES AND OTHER BUILDINGS.

FIGURE 8 CONTINUED)

POOR BETTER

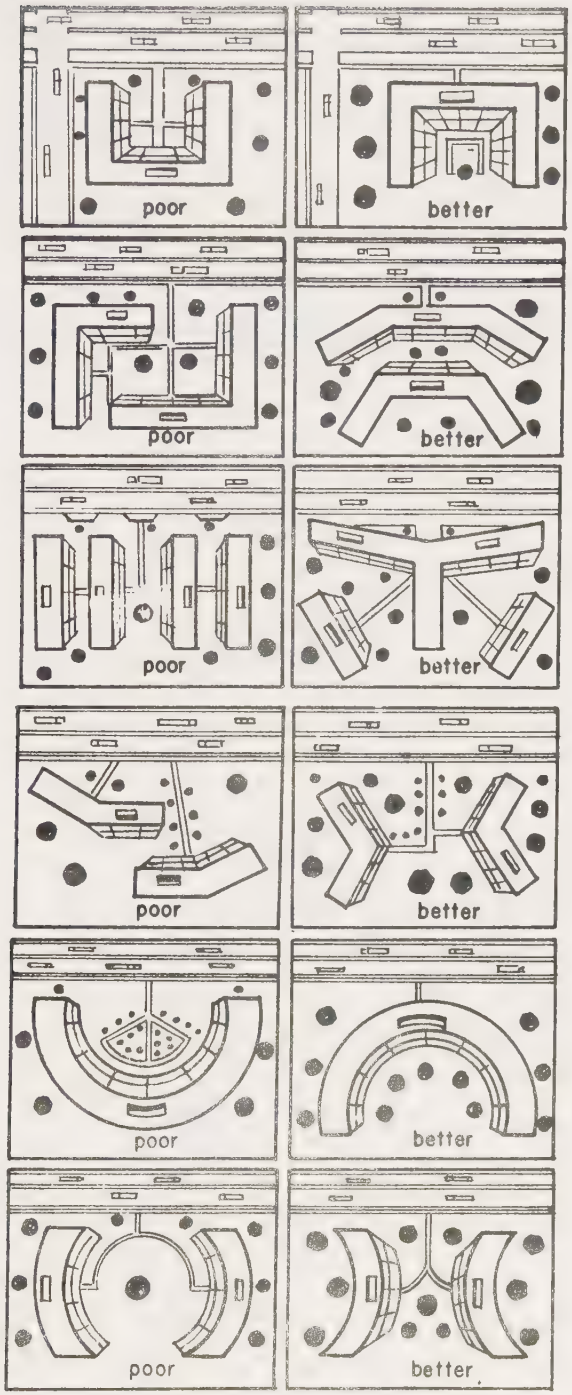


FIGURE 9

BUILDING ORIENTATION ON SITE

FOR NOISE MITIGATION

FIGURE 10

SINGLE EVENT SOUND LEVELS AND HUMAN RESPONSE

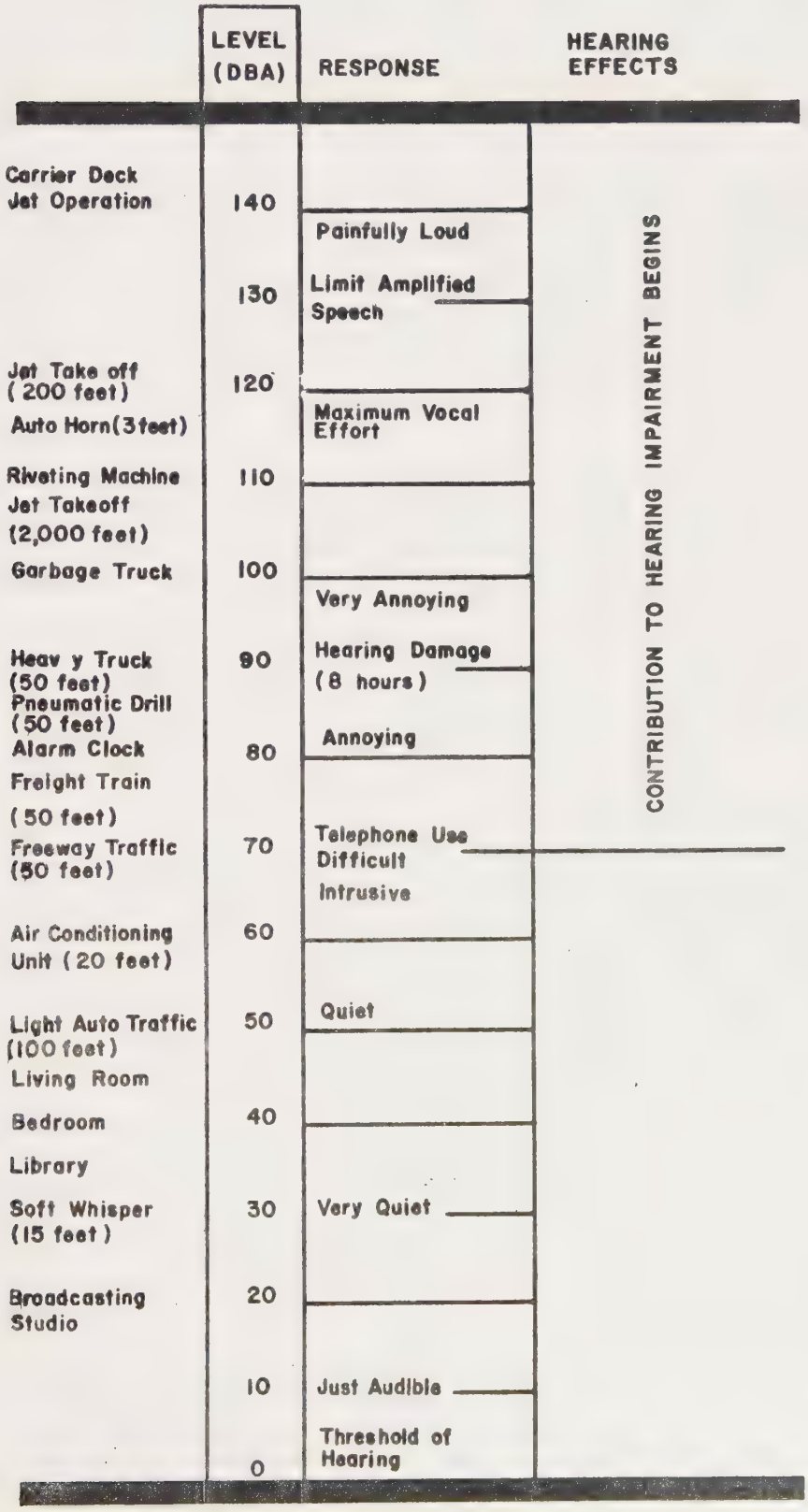


FIGURE 10

c. Incidental Noise. Zoning decisions usually account for the fact that certain land uses have inherent incidental type noises. This is reflected in the tolerances in industrial areas for machinery generated noise and the like. Thus, higher tolerances can be recommended in developing standards for industrial areas. Nevertheless, certain planned industrial and commercial areas may have lower noise tolerances, as in an industrial park concept. Nuisance noises, in addition, may be more tolerable in certain areas, but should nevertheless be subject to enforcement. Establishment of a "free noise" zone is not desirable.

d. Performance Standards. An evolving concept is that of performance standards which define and allocate a land use according to its environmental effects, rather than use category. However, there are problems in issuing permits and monitoring and enforcement. One example of a problem is a change in ownership of a plant, introducing new machinery or procedures and, consequently, changing noise impact. What may be more valuable is a modification of the concept to consider environmental effects without giving up the hedge of land use classification.

An approach commonly found in zoning ordinances is the listing in industrial zone provisions of a number of adverse environmental effects, such as noise, vibration, smoke, dust, odor, and the like. Noise in this approach would not be given separate import, but would be included in a list of general effects which should not cause adverse effect as measured at the property line. Precise listing of noise emission standards is also possible. Adherence to the land use standards recommended within this element will tend to reduce the need for performance standards, but they should be considered useful where the land use standards may not be strictly applicable.

e. Airport Areas. A distinct problem is land use planning around airport areas. Facilities such as schools, hospitals and rest homes should not be located under or near flight paths because of noise and safety considerations. In some cases, insulation may be required if certain uses are located near airports. Industrial uses appear to be most suitable to airport noise impacted areas, and have the advantage that their sturdier construction provides more efficient noise insulation. Land use decisions in airport areas should be guided by the noise element standards and state laws.

f. Ground Rapid Transit Facilities. The only major mass transit facilities in Kern County utilize the existing highway system. Any reduction in the noise level from the highway network will reduce the impact from the rapid transit facilities. Routing should be conducted along major thoroughfares.

3. Urban Design

a. Feasibility. The inventory of techniques found in urban design, such as building arrangement, parking lot location, landscaping, can be used as noise attenuation tools. These frequently are beyond the scope of zoning controls, which generally are a minimum

to protect the public health, safety, or welfare. Some noise impact is recognized in the case of planned development permits. However, creating a desirable planned development design may not be an optimum solution as far as noise is concerned. For example, a centralized park-like "common" may be desirable for central access whereas a strip park on the periphery of a development may be more desirable as a "noise setback area."

b. Advice and Guidance. Designs should always be flexible and local planning agencies can serve well by guding and advising on noise consideratons where precise controls are not possible. Figures 15 and 16 represent various flexible design considerations which local planning agencies may utilize. In residential areas, especially with the design flexibility of medium densities, noise can be an important consideration. For example, sleeping areas can be oriented away from noise sources. Walls facing noise sources can be windowless. Building shapes can be angled to buffer sound without adversely reflecting or channelizing it. Garages are often grouped and available as buffers, although the image from the roadway of such a buffer should be "softened," as with planting. Similarly, large commercial or industrial buildings have effects on nearby residential land uses. These large buildings can either be beneficial mitigators of noise, or may adversely reflect sound to where it is unwanted.

4. Environmental Impact Reports

a. Background. Noise as a potential environmental impact of new developments is recognized by State guidelines requiring that effect on the ambient noise levels be a criterion for judging if a project has a significant effect on the environment. Standards, criteria, noise contours, and other background resources developed as part of the Noise Element enable more detailed analysis in preparing and reviewing Environmental Impact Reports. Because of the many parameters involved, separate noise evaluations may be required for each Environmental Impact Report.

b. Noise - Generation. Most development creates noise impact, principally through vehicle generation. The number of vehicles generated for a residential development, both by homeowners and visitors, can be inserted into traffic volume noise assessment calculations to judge the additional generation of noise and to determine if barriers will be required. On an individual basis, this may not be very crucial because of the low volumes involved. The addition to vehicle volumes on collector and arterial streets should also be evaluated and indeed may be more significant.

Industrial and commercial development may significantly increase truck traffic. An increase in volumes could conceivably move a noise generation effect from an acceptable to un-

acceptable category, as seen from use of HUD's Noise Assessment Guidelines. Truck noise is especially important because of the high impact of one diesel truck, roughly equivalent to thirty automobiles. A similar analysis reflecting volumes and incremental noise generation is required with truck noise. In addition, there are short-run effects of construction noise and material transport, which can be treated by a community noise control ordinance.

Secondly, there is the noise generation by the land use activity itself to be considered. References need to be expanded on the noise generation of various land uses and activities.

A third consideration is the cumulative effect of environmental impacts. This relates to the insidious growth of noise mentioned earlier. Ambient noise levels should be regularly monitored to determine if degradation of the noise environment is occurring.

c. Noise Environment. The emphasis of EIR's is the assessment of the impact of a project on the surrounding area, inventory of natural resources, and the like. However, in reality there may be a much greater impact on the project by surrounding noise producing agents, both existing and projected. For example, noise levels, but may simultaneously expose residents to undesirable levels of noise from an adjacent freeway. Development and refinement of noise contours of transportation elements as required under State Noise Element requirements will indicate the amount of exposure.

VI

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VIII

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appendices

This appendix contains brief technical explanations of sound and its properties. It is intended for those readers with some technical background who desire a fuller description of the problem of noise and its control. The information presented here is not essential to an understanding of the Noise Element and the Arvin Noise Control Program. It is included only as added information for those who desire it.

APPENDIX A

EXCERPT FROM GOVERNMENT CODE - STATE OF CALIFORNIA

NOISE ELEMENT

1. AUTHORITY

Section 65302 (g) requires a noise element of all city and county general plans, as follows:

> A noise element in quantitative, numerical terms, showing contours of present and projected noise levels associated with all existing and proposed major transportation elements. These include but are not limited to the following:
>
> (1) Highways and freeways
>
> (2) Ground rapid transit systems
>
> (3) Ground facilities associated with all airports operating under a permit from the State Department of Aeronautics.
>
> These noise contours may be expressed in any standard acoustical scale which includes both the magnitude of the noise and frequency of its occurrence. The recommended scale is sound level A, as measured with A-weighting network of a standard sound level meter, with corrections added for the time duration per event and the total number of events per 24-hour period.
>
> Noise contours shall be shown in minimum increments of five decibels and shall be continued down to 65 dB (A). For regions involving hospitals, rest homes, long-term medical or mental care, or outdoor recreational areas, the contours shall be continued down to 45 dB (A).
>
> Conclusions regarding appropriate site or route selection alternatives or noise impact upon compatible land uses shall be included in the general plan.
>
> The state, local, or private agency responsible for the construction or maintenance of such transportation facilities shall provide to the local agency producing the general plan, a statement of the present and projected noise levels of the facility, and any information that was used in the development of such levels.

2. THE SCOPE AND NATURE OF THE NOISE ELEMENT

A. A statement of general policy indicating the local jurisdiction's general intentions regarding noise and noise sources in the community.

B. Desired maximum noise levels by land use categories.

C. Standards and criteria for noise emissions from transportation facilities. (It should be noted that control of some noise sources has been pre-empted by State and Federal governments.)

D. Standards and criteria for compatible noise levels for local "fixed-point"noise sources.

E. Guide to implementation.

F. Appendix describing methodology of preparation and sources of data.

3. METHODOLOGY

A. Preliminary identification of problem noise areas.

B. Collect data on existing and proposed transportation noise sources. Such transportation noise data is to be provided by the agency constructing and operating the facilities. Such data may be expressed in the acoustical scale recommended in Section 65302 (g), or any professionally acceptable acoustical scale used consistently throughout the preparation of the noise element.

C. Collect data on general noise levels throughout the community related to types of use. In collecting data, the differences among kinds of noises should be recognized. The impact of noise on the individual varies with its frequency, pitch, duration and cyclic consistency; the presence of masking noises in the environment; and the sound's familiarity.

D. Review information from published sources regarding effects of noise on people'd activities, health and well being.

E. Establish committees or other procedures for developing citizen input and awareness of problems, issues and opportunities.

F. Survey noise control regulations from other jurisdictions giving special attention to regulatins from jurisdictions with characteristics similar to the local community.

G. Formulate general policy statements responsive to local issues and problems.

H. Prepare standards and criteria relating noise levels to types of use and environmental factors.

I. Set measurable goals for the reduction of noise in problem areas.

4. DEFINITION OF TERMS

Sound intensity: A measure of the loudness of sound.

Noise contour: A line on a map passing through points when the same sound intensity level prevails. Contours form bands of varying width emanating from a noise source.

5. RELATIONSHIP OF THE NOISE ELEMENT

A. To Other Elements:

The noise element is related most closely to the circulating, land use and housing elements, since it provides noise level standards related to the compatibility of land use, of which residential use will be a highly important component. Noise level standards thus can be the decisive factor in locating transportation facilities (or their design) in relation to existing or planned land use. Consideration should be given to the adverse effects of noise on activities taking place both in the out-of-doors and in structures not insulated against sound. The noise element is also closely related to the open space element since noise can adversely affect the enjoyment of quiet pursuits in open space. Conversely, open space can be employed to buffer noise sources from sensitive uses through distance and extensive tree planting.

B. To Environmental Impact Questions:

Social: Excessive noise is socially disruptive, and may be physically and psychologically damaging.

Economic: Excessive noise adversely affects property values and levels of productivity. In the past the costs of excessive noise from transportation facilities have been passed on to those in the vicinity rather than being borne by the producer of the noise.

C. To Other Agencies:

The law requires state, local or private agencies responsible for the construction and maintenance of major transportation facilities to provide present and projected noise levels for their facilities. This includes (but is not limited to):

State Department of Transportation
Regional Transit Authorities
Local Public Works departments
Rapid transit districts
Airport ground facilities
Private air carriers
Private freight carriers
Railroad companies

6. IMPLEMENTATION

A. Noise ordinances and regulations. The zoning ordinance may be utilized since it can vary levels of permissible noise by zoning district-related noise level to type of use and situation.

B. Maintain liaison with transportation agencies regarding reduction in noise from existing facilities and control of noise through design and location and new facilities.

C. Revise other elements of general plan as appropriate to give recognition to noise level/land use relationships and other relevant matters. Revise circulation element to divert through traffic from residential streets.

D. Revise building code to reduce noise transmission in or from building and provide for additional sound insulating in high noise areas.

E. Liaison with health departments in the preparation of standards and ordinances and for assistance in onsite measurements of noise level.

F. Construct sound barriers, particularly surrounding noise intolerant areas such as between residential areas and freeways.

APPENDIX B

DEFINITIONS

TERMINOLOGY FOR COMMUNITY NOISE*

Ambient Noise - See Page 11 (note)

The following contains some definitions of most of the principal terms used in the description of community noise, particularly around airports. For additional definitions, refer to American Standard Acoustical Terminology, S1. 1-1960, Revision of Z24. 1-1951 and including Z24.1a, American Standards Association, May 26, 1960.

SOUND PRESSURE

The sound pressure at a point is the total instantaneous pressure at that point in the presence of a sound wave minus the static pressure at that point.

LEVEL

In acoustics, the level of a quantity is the logarithm of the ratio of that quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be specified.

Note 1: Examples of kinds of levels in common use are electric power level, sound-pressure-squared level, and voltage-squared level.

Note 2: The level as here defined is measured in units of the logarithm of a reference ratio that is equal to the base of logarithms.

Note 3: In symbols,

$$L=\log_r (q/q_0)$$

where

L = level of kind determined by the kind of quantity under consideration, measured in units of $\log_r r$

r = base of logarithms and the reference ratio**

q = quantity under consideration

q_0 = reference quantity of the same kind

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* Wyle Laboratories

** Throughout this brief on terminology, the base of the logarithm will be 10.

Note 4: Differences in the levels of two like quantities q_1 and q_2 are described by the same formula because, by the rules of logarithms, the reference quantity is automatically divided out:

$$\log_r (q_1/q_0) - \log_r (q_2/q_0) = \log_r (q_1/q_2)$$

DECIBEL

The decibel is one tenth of a bel. Thus, the decibel is a unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power.

Note 1: Examples of quantities that qualify are power (any form), sound pressure squared, particle velocity squared, sound intensity, sound-energy density, boltage squared. Thus the decibel is a unit of sound-pressure-squared level; it is common practice, however, to shorten this to sound pressure level because ordinarily no ambiguity results from so doing.

Note 2: The logarithm to the base the tenth root of 10 is the same as ten times the logarithm to the base 10: e.g., for a number X^2, $\log_{10} 1/10\ X^2 = 10 \log_{10} X^2 = 20 \log_{10} X$. This last relationship is the one ordinarily used to simplify the language in definitions of sound pressure level, etc.

SOUND PRESSURE LEVEL

The sound pressure level, in decibels, of a sound is 20 times the logarithm to the base 10 to the ratio of the pressure of this sound to the reference pressure. The reference pressure is 20 micronewtons per square meter.

ONE-THIRD OCTAVE BAND SOUND PRESSURE LEVEL

The one-third octave band sound pressure level of a sound for a specified frequency band is the sound pressure level for the sound contained within the restricted band.

SOUND LEVEL (NOISE LEVEL)

Weighted sound pressure level measured by the use of a metering characteristic and a weighting A, B, or C, as specified. The weighting employed must be indicated, otherwise the A-weighting is understood. The reference pressure is 20 micronewtons per square meter (2×10^{-4} microbar). Unit: decibel (dB). See page IV-4 for additional information regarding the A-weighted scale.

AMBIENT NOISE LEVEL

Ambient Noise Level is defined as the all-encompassing noise associated with a given environment, being usually a composite of sounds from many sources near and far. For the purposes of this element, ambient noise level is the level obtained when the noise level is averaged over a period of 15 minutes or some other predetermined time interval, without the inclusion of noise from isolated identifiable sources. In this element, the L_{50} level is used as a comparative index of the ambient noise levels.

STATISTICAL LEVELS

Any of the statistical noise levels is given in terms of the value of the noise level which is exceeded for a stated percentage of the time period dur-

ing which the measurement was made. The symbol for the noise level which is exceeded y percent of the time is Ly.

The most common measures utilized are L_{99}, L_{90}, L_{50}, L_{10} and L_1, which denote the value of the noise level which is exceeded 99, 90, 50, 10, and 1 percent of the time respectively. See page IV-4 for additional information regarding the L_{10} level.

ENERGY EQUIVALENT NOISE LEVEL

The energy equivalent noise level for a stated period is the level of a constant, or steady state, noise which has an amount of acoustic energy equivalent to that contained in the measured noise. The symbol for the energy equivalent noise level is L_{eq}. Its mathematical definition is:

$$L_{eq} = 10 \log_{10} \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} 10^{\frac{NL}{10}} dt \right]$$

where NL is the measured noise level as a function of time and t_1 and t_2 denote the times at the beginning and ending of the measurement period.

RESIDUAL NOISE LEVEL

The residual noise level is the level of the all encompassing unidentifiable noise which remain after all identifiable noises have been eliminated. L_{90} can be used as an estimate of the residual noise level when no steady state identifiable noises are known to be present.

NOISE EXPOSURE AND NOISE LEVEL SCALES

"Noise exposure is the integrated effect, over a given period of time, of a number of different events of equal or different noise levels and durations". The integration may include weithting factors for the number of events during certain time periods in which people are more anoyed by noise (e.g. sleep interference by noise at night).

The various scales for noise exposure or noise level in use throughout the world differ according to the particular method of integration or summation, time period weighting factors, or frequency weightings.

The following summarizes the essential features of and correlation between three noise scales currently used in the United Stated for noise exposure from aircraft noise. The correlations are necessarily approximate, but are considered valid for interrelating evaluations of aircraft noise exposure at major airports served by current commercial jet aircraft. The definitions used herein are not always the same as thos formally given in the source references. In all cases, however, the simplified form given here is an exact equivalent or valid approximation thereto.

Noise Exposure Forecast (NEF)

A method currently in wide use for making noise exposure forecasts utilizes a Perceived Noise Level scale with additional corrections for the presence of pure tones. Two time periods are used to weight the number of flights (Galloway, W.J. and Bishop, D.E., "Noise Exposure Forecasts: Evolution, Evaluation, Extensions and Land Use Interpretations," FAA-NO-70-9, August 1970).

The Single Event Noise Level is defined in terms of Effective Perceived Noise Level (EPNL) which can be specified approximately by:

$$EPNL = PNL_{max} + 10 \log \frac{t_{10}}{20} + F, \text{ EPNdB}$$

where

PNL_{max} = maximum Perceived Noise Level during flyover, in PNdB,

t_{10} = 10 dB down duration of the Perceived Noise Level time history, in seconds,

F = pure tone correction. Typically, F = +3 dB

and

Community Noise Exposure is specified by the quantity, Noise Exposure Forecast (NEF).

For a given runway and one or two dominant aircraft types, the total NEF for both daytime and nighttime operations can be expressed approximately as:

$$NEF = \overline{EPNL} + 10 \log N_f - 88.0$$

where

$\overline{EPNL}$ = energy mean value of EPNL for each single event at the point in question

$N_f = (N_d + 16.7\ N_n)$ or

$= (15\bar{n}_d + 150\bar{n}_n)$

$N'_d, \bar{n}_d$ = the total number and average number per hour, respectively, of flights during the day period 0700 to 2200

$N_n, \bar{n}_n$ = the total number and average number per hor, respectively, of flights during the night period 2200 to 0700

The constant (-88.0) dB includes an arbitrary -75 scale-changing constant and a reference number of daytime flights of 20. The constant 16.7 accounts for the 10-to-1 weighting factor for flights during the 9-hour period.

Composite Noise Rating Method (CNR)

The original method for evaluating land use around civil airports is the Composite Noise Rating (CNR). It is still in wide use by the Federal Aviation Administration and the Department of Defense for evaluating land use around airfields (Civil Engineering Planning and Programming, "Land Use Planning with Respect to Aircraft Noise," AFM 86.5, TM 5-365, NAVDOCKS P-98, October 1, 1964). This noise exposure scale may be expressed as follows:

The Single Event Noise Level is expressed (without a duration or tone correction) as simply the maximum Perceived Noise Level (PNL_{max}) in PNdB.

The noise exposure in a community is specified in terms of the Composite Noise Rating (CNR), which can be expressed approximately as follows:

$$CNR = \overline{PNL}_{max} + 10 \log N_f - 12$$

where

$\overline{PNL}_{max}$ = approximate energy mean maximum Perceived Noise Level (PNL) at a given point

N_f = same as defined for NEF. The actual method for accounting for the number of flights and time periods uses discrete interval correction factors. These have been approximated by the use of the equivalent continuous weighted number of flights, N_f.

Community Noise Equivalent Level (CNEL)

The following simplified expressions are derived from the exact definitions in the report, "Supporting Information for the Adopted Noise Regulations for California Airports." They can be used to estimate values of CNEL where one type of aircraft and one flight path dominate the noise exposure level.

Single event noise is specified by the Single Event Noise Exposure Level (SENEL) in dB and can be closely approximated by:

$$SENEL = NL_{max} + 10 \log t_{ea}, \quad dB$$

where

NL_{max} = maximum noise level as observed on the A-scale of a standard sound level meter

and

t_{ea} = effective time duration of the noise level (on A-scale) in seconds

The effective duration is equal to the "energy" of the integrated noise level (NL), divided by the maximum noise level, NL_{max}, when both are expressed in terms of antilogs. It is approximately one-half on the 10 dB down duration, which is the duration for which the noise level is within 10 dB of NL_{max}.

A measure of the average integrated noise level over 1 hour is also used in the California Airport Noise Regulation. This is the Hourly Noise Level (in dB), defined as:

$$HNL = \overline{SENEL} + 10 \log n - 35.6, \quad dB$$

where

$\overline{SENEL}$ = energy mean value of SENEL for each single event,

and n = number of flights per hour

The total noise exposure for a day is specified by the Community Noise Equivalent Level (CNEL) in dB, and may be expressed as:

$$CNEL = \overline{SENEL} + 10 \log N_c - 49.4, \quad dB$$

where

$$N_c = (N_d + 3N_e + 10N_n)$$

$$= (12\bar{n}_d + 9n_e + 90\bar{n}_n)$$

or

N_d'$\bar{n}_d$ = total number and average number per hour, respectively, of flights during the period 0700 to 1900

N_e'$\bar{n}_e$ = total number and average number per hour, respectively, of flights during the period 1900 to 2200

and

N_n'$\bar{n}_n$ = total number and average number per hour, respectively, of flights during the period 2200 to 0700

Day-Night Average Sound Level (L_{dn})

A new composite noise scale is currently under consideration by the Environmental Protection Agency for specification of community noise from all sources. Called Day-Night Average Sound Level, it is nearly the same as CNEL except that the weighting for the evening time period in CNEL is eliminated and the "day" extends from essentially 7:00 a.m. to 10:00 p.m., while the "night," with a 10 dB weighting penalty, extends from 10:00 p.m. to 7:00 a.m.

Defined in the approximate manner as above,

$$L_{dn} = \overline{SENEL} + 10 \log N_e - 49.4$$

where

$$N_e = N'_d + 10\, N_n$$

N'_d = total number of events (flights) during the daytime (0701 to 2200)

N_n = total number of events (flights) during the nighttime (2201 to 0700)

$\overline{SENEL}$ = energy mean value of SENEL for each single event

When defined in the more general way for application to continuous monitoring of community noise, L_{dn} would be given by:

$$L_{dn} = 10 \log \left[\frac{15}{24} \cdot \log^{-1}\left(\frac{\overline{L_d}}{10}\right) + \frac{9}{24} \cdot \log^{-1}\left(\frac{\overline{L_n} + 10}{10}\right) \right]$$

where

$\overline{L_d}$ = energy mean A-weighted noise level during the daytime (0701 to 2200)

$\overline{L_n}$ = energy mean A-weighted noise level during the nighttime (2201 to 0700)

$\log^{-1}$ = denotes an inverse logarithm

Aircraft Sound Description System (ASDS)

The Federal Aviation Administration (FAA), in a recent report FAA-EQ-73-3, "Aircraft Sound Description System - Background and Application," has defined a new system for describing aircraft noise around airports. The system, abbreviated ASDS, is straightforward but differs substantially from the preceding scales. At any point near the airport, exposure to aircraft noise is described in terms of the total amount of time in minutes that sound levels exceed a prescribed A-weighted noise threshold value of 85 dB(A). (This threshold level is roughly equivalent to a Perceived Noise Level of 97 PNdB).

For example, a point to the side of a single busy runway might be exposed to aircraft noise during takeoff above 85 dB(A) for a total period of (say) 30 minutes a day. This exposure number can be specified for any period of the day desired. No attempt is made with ASDS to use weighting factors to account for greater sensitivity of people to intruding noise at night.

Finally, a composite single number "Situation Index" (SI) can be defined for an airport with the ASDS system which defines the total integrated value of the product of exposure time in minutes above 85 dB(A) and the area exposed. The mathematical expression for this is given by:

$$SI = \sum_{j=1}^{m} \sum_{i=1}^{n} A_{ij} \; N_{ij} \; t_i$$

SI = Situation Index value (acre-minutes)

where

A_{ij} = area (acres) exposed to 85 dB (A) or higher for airplane "j" in event type "i" (event types can be differntiated by operation (take-off or landing), gross weight, flight path or any other characteristic as desired).

N_{ij} = number of events of type "i" performed by airplane "j"

t_i = approximate time duration appropriate to event type "i"*

m = total number of airplane types

n = total number of event types for each airplane

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*The time for which the noise level exceeds 85 dB(A) on the ground for event "i" can be approximated as 1/4 minute for each takeoff event and as 1/6 minute for each landing event.

COMPARISON OF COMPOSITE RATING SCALES FOR SPECIFYING COMMUNITY NOISE EXPOSURE

The basic expressions defined above for specifying community noise exposure are summarized below. The weighted number of events (N_f, N_c, or N_e) are defined above.

Noise Exposure Forecast	$NEF = \overline{EPNL} + 10 \log N_f - 88$, dB
Composite Noise Rating	$CNR = \overline{PNL}_{max} + 10 \log N_f - 12$, dB
Community Noise Equivalent Level	$CNEL = \overline{SENEL} + 10 \log N_c - 49.4$, dB
Day-Night Average	$L_{dn} = \overline{SENEL} + 10 \log N_e - 49.4$, dB

For practical purposes, the following approximate conversions can be used.

$$CNEL = L_{dn} = NEF + 35 = CNR - 38$$

The ASDS system is too new to permit any simple conversions to be made at this time between its index values and the other noise scales.

APPENDIX C

NOISE AND ITS EFFECTS ON PEOPLE

Sound, so vital a part of our existence, is growing to such disagreeable proportions within our environment that today it is a very real threat to our health.*

So noisy, in fact, is America's urban environment that people living in congested sections of large cities may be hearing far less than they realize; many are developing severe hearing loss. Suburbanites will not fare much better. As noise levels in their communities continue to increase, they may be destined for the same fate.

The problem is not limited to the out-of-doors. Noise in our homes is beginining to reach harmful levels. We are using more tools and appliances and, as their power has increased, so has the noise. The combination of hi-fi equipment and the rock music which dominated the past decade has probably affected the hearing of a whole generation of listeners.

If these statements seem frightening, they should. They are not exagerations. Noise pollution is a growing menace, not just to boilermakers and jackhammer operators, but to all of us. The noise level we experience daily has increased so gradually that we fail to recognize its danger. But noise is a danger. It can result in a hearing loss that not only can be a handicap, but what is worse, a hearing loss that cannot be restored.

Unless controlled, noise pollution will exact an increasingly heavy toll on society. Already an estimated 16 million people in the United States suffer from some degree of hearing loss directly caused by noise. Such hearing loss, in fact, is a major cause of industrial injury. Compensation to its victims annually runs into millions of dollars.

Although definitive research has yet to be done, some recent studies suggest that existing noise levels may be a cause in the rising rates of heart disease, ulcers and mental illness and may even adversely affect the unborn child. The danger from noise is very real.

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* Most of this section is abstracted from two U.S. Environmental Protection Agency reports: Noise Pollution, August 1973, and Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure, July 1973.

A. Noise - Unwanted Sound

Sound moves through the air somewhat like waves move in the ocean. In sound, the waves are alternate rings of compressed, and then rarefied air moving away from a central source at a constant speed. As each wave- first a compression, then a rarefaction - encounters an object, it exerts a force - a push, then a pull - on the object. This is why sound can break a glass or cause a window screen to vibrate.

For humans, sound has two significant characteristics: pitch and loudness. In terms of affecting people, pitch is often an annoyance, ie., the sound of chalk scraped over a blackboard surface. Pitch is the "height or depth" of a tone or sound depending on the relative rapidity of the vibrations by which it is produced. In low-pitched sounds, the vibrations are relatively far apart. In high-pitched sounds, they are squeezed closer together.

Loudness, on the other hand, can affect our ability to hear. It is the intensity of the sound waves combined with the reception characteristics of the ear. The intensity of a sound wave may be compared with the height of an ocean wave. In terms of sound's effect, this intensity is how hard a sound wave hits an object, a characteristic which can be measured precisely with instruments. But the loudness heard by a human ear is slightly different from the purely physical values. Our ears hear sound at intermediate frequencies better than sound at very low or very high requencies.

Sound is measured by decibels. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect.

Decibels are not linear units like miles or pounds. Rather, they are representative points on a sharply rising curve. Thus, while 10 decibels is 10 times more intense than one decibel, 20 decibels is 100 times more intense (10 X 10), 30 decibels is 1,000 times more intense (10 X 10 X 10) and so on. One hundred decibels, therefore, is 10 billion times as intense (that is, represents 10 billion times as much accustic energy) as one decibel. The reason for such a complicated scale is simply that the human ear detects a wide range of acoustic energy.

Sound levels are measured at a discrete distance from their source; their decibel rating decreases as the distance from the source increases. These ratings should be used primarily for comparative purposes.

The gentle rustle of leaves, for example, is rated at 10 decibels, while a typical office has about 50 decibels of background noise. Moderate traffic noise ranges around 70 decibels; a police whistle hits 80. Subways and elevated trains rank just below thunder at 100 decibels. At just above 120 decibels the ear begins to feel pain. Figure 10 gives noise levels produced by various noise sources and the human response to each level.

B. Noise Measurement Scales

In addition to loudness and pitch, sound also varies by time. It can be constant or intermittent; it can occur during the day or at night (when it is more disturbing). There are several noise measurement scales which are used to describe the noise in a particular location.

1. A-Weighted Sound Pressure Level, dBA. This scale includes a selected range of frequency expressed in decibels. The "A-weighted" scale or filter was selected to give greater weight to the frequencies of sound to which the human ear is most sensitive, primarily the middle frequencies. Sound pressure level measurements in dBA are used in almost all measurement scales which are used to describe noise that affects people.

2. L_{10} Statistical A-Weighted Noise Level. The L_{10} level represents the A-Weighted noise level which is exceeded 10 per cent of the time for which the noise is measured. This measurement scale is commonly utilized for the assessment of traffic noise. It represents the louder sound levels occurring during the measurement period. A percentile scale can be used for other levels, such as L_{50}, which is the noise level which is exceeded 50 per cent of the time, and so on.

3. Community Noise Equivalent Level, CNEL. CNEL is a measure of the cumulative noise exposure in the community, with greater weights applied to evening and nighttime periods. For CNEL calculations, day is defined as 7:00 A.M. to 7:00 P.M. with a weighting factor of unity. Evening is 7:00 P.M. to 10:00 P.M. with a weighting factor of 3. Night is defined as 10:00 P.M. to 7:00 A.M. with a weighting factor of 10. Noise occurrences at night are given greater weight because noise at that time is more disturbing. CNEL is the scale used to measure noise level of commercial and general aviation airports in California.

4. Day-Night Average Sound Level, L_{dn}. The day-night level is essentially the same as CNEL with the exception that the evening time period has been dropped and all occurrences during this three-hour period are grouped into the daytime period. Noise contours developed by CNEL and L_{dn} procedures will normally agree within 1 decibel, which is an indistinguishable difference.

   The L_{dn} technique represents the evolution of CNEL in that time method provides computational simplification of an established rating scale with no significant loss of accurancy. The L_{dn} scale was chosen for preparing noise contours in the vicinity of freeways, highways, and railroads in Kern County in accordance with the findings of Wyle Laboratories.

   Other measurement scales have been used, especially for the description of airport noise. One is Noise Exposure Forecast (NEF). Another is Community Noise Response (CNR). All four scales (CNEL, L_{dn}, NEF and CNR) can be converted from one to another with reasonable accuracy. L_{dn} was chosen for use in this work because it has been recommended for nationwide use by an EPA Task Force.

C. Damage to Hearing

Noise of 120 decibels and higher will cause ear pain. Pain occurs as the ear unsuccessfully attempts to protect itself through a mechanism physicians call "the acoustic reflex." When sound enters the ear, the waves pass through the ear canal to the eardrum which vibrates. The eardrum conducts these vibrations to three bones called ossicles - the three tiniest bones of the body. It is here that the acoustic reflex occurs. The ossicles change the loudness of sound before it enters the inner ear. Normal action of the ossicles may amplify soft sounds or dampen loud sounds as their tiny muscles contract to decrease the pressure of the sound waves.

The acoustic reflex protects the inner ear from extra loud sounds by reducing them, just as the eye protects itself from extra bright light by contracting the pupil. The ear is not completely successful in this task. The reason is twofold: first, the reflex occurs on command from the brain a few hundredths of a second after the loud sound is first sensed. Thus, at least some of the sound at full loudness gets through to the delicate inner ear before the reflex goes into operation. Second, muscles cannot contract indefinitely so their sound-dampening capacity is limited. Thus, if the sound is sustained, the inner ear may still be bombarded with excessive sound pressure even after the reflex has had a chance to work. In the case of impulse sounds such as a gunshot, the reflex is virtually useless as a defense.

What happens when sounds enter the inner ear? The ossicles transmit the vibrations to a fluid contained in a tiny, snail-shaped structure called the cochlea. Within the cochlea are microscopic hair cells that move back and forth in response to the sound waves just as seaweed on the ocean floor undulates in response to wave action in the ocean. It is the energy impulses created by the movement of these crucial hair cells that go to the brain where they are interpreted as sound. But just as the seaweed can be torn and ripped by violent wave action in the ocean, so too, can hair cells be damaged by intense sound waves.

When intense sound waves occur only briefly, the damage may be temporary. But if loud noises are frequent or sustained, the damage may be permanent, and such noise-induced hearing loss cannot be restored either through surgical procedures or hearing aids. Permanent loss, however, usually occurs only in certain frequencies because different hair cells respond differently to various frequencies. Unfortunately, the hair cells that seem to be the most susceptible to damage are those that respond to high frequencies.

This selective damage can severely impair the understanding of human speech. It may be even more insidious than a broad-range hearing loss because it may not be readily recognized. Recent studies of young school children, thought to be "slow learners" revealed that at least some of them simply could not hear everything that was being said in the classroom. Once adjustments were made, these children were able to match the scholastic performance of their classmates. Similar undetected hearing difficulties may be the cause of unexplained performance impairment among adults.

Obviously, noise may accelerate the progressive loss of hearing we all suffer as we grow older. To learn just how much, scientists visited an isolated area in Africa to examine the hearing acuity of a large number of elderly tribesmen and their youthful counterparts. Their findings: men in their 70's and 80's had hearing sensitivity nearly equal to that of the young boys and equivalent to that of Americans 30 to 40 years their junior.

Undetected hearing loss is a clear danger to each of us. We are dependent on a wide variety of audible signals, many of them for our safety. Consider the danger to a driver or pedestrian who cannot hear the siren of a fire engine, or the construction worker who does not hear the warning whistle before an explosive charge is detonated.

A Task Group appointed by the Environmental Protection Agency (EPA) to carry out part of its responsibility under the Noise Control Act of 1972 has reviewed the research on levels of noise that cause hearing loss. Table 1 summarizes that research. It shows the relationships between daily noise exposure level and noise induced hearing loss for the most sensitive 10 per cent of the population. For example, the lowest 4000 hertz (Hz) frequency sound level that can be heard by a person who has been exposed to an 85 decibel average sound level for 40 years is 19 decibels louder than the lowest level he was able to hear at the beginning of the 40 years prior to noise exposure. His hearing loss (or threshold shift) has been 19 decibels at that frequency. The Task Group concludes:

> "that a day-night average sound level less than 83 dBA is required, to assure that at least 90 per cent of the general population have no measurable loss of hearing ability over the 500 to 4,000 Hz range of frequency. Such cumulative effects of environmental noise would show up only after exposures exceeding 10 years. This means that hearing damage data on which to base criteria of acceptable noise exposure, or to modify the initial choice of criteria, accrue very slowly. Prudence demands a conservative approach to setting criteria in such a situation. Moreover, the 83 dBA limit was derived under certain assumptions regarding life style and exposure that might lead to over- or underestimation of individual exposures. Therefore, in view of the latter uncertainty, it is judged reasonable to recommend an L_{dn} of 80 dB as the maximum permissible yearly outdoor average sound level, to prevent adverse health effects on people's hearing."

Work done by other groups at EPA has also confirmed the establishment of this level.*

D. Interference with Conversation

Another detrimental effect of noise is to drown out sounds we want to hear such as speech. When background noise exceeds 50-60 decibels, conversation is impaired. Figure 11 shows how loud a person must speak to make himself heard with different background noise levels.

* See Public Health and Welfare Criteria for Noise, July 27, 1973, #550-9-73-02; and Effects of Noise on People, December 3, 1971, #NTID 300.7.

TABLE 4

HEARING LOSS FROM NOISE EXPOSURE

Maximum noise induced permanent threshold shift (hearing loss) in decibels, at various audiometric frequencies, for the most sensitive 10 per cent of the population, assuming a 40-year exposure for 8 hours per day, as a function of the A-weighted average sound level of broad-band noise.*

Audiometric Frequencies Hertz (Hz)	A-weighted Average Sound Level in dB**			
	75	80	85	90
Average shift at 500, 1,000, and 2,000 Hz	1	1	4	7
Average shift at 500, 1,000, 2,000 and 4,000 Hz	2	4	7	12
Shift at 4,000 Hz	6	11	19	28

* Example: Of a large number of people exposed for 8 hours per day over a 40-year working lifetime to broad-band noise with A-weighted average sound level of 85 dB, the most sensitive 10 per cent of these people will exhibit, on the average, permanent threshold shifts as follows: at a frequency of 4000 Hz, the shift will be 19 dB; the average of the shifts at the frequencies 500, 1,000, 2,000 and 4,000 Hz will be 7 dB; the average of the shifts at 500, 1,000 and 2,000 Hz will be 4 dB.

** Add 5 dB to average sound level for intermittent noise such as that produced by aircraft operations.

The EPA Task Group mentioned above has also evaluated the effects of background noise on conversation. They have concluded:

> "that the outdoor day-night average sound level should not exceed 63 dB if people are to enjoy their normal domestic activities indoors or to converse without difficulty outdoors at a two meter distance" (a common face-to-face distance for conversation).

E. Sleep Disturbance

Noise can interfere with sleep by either awakening a person or causing a shift from a deep sleep level to a shallower level. Brief sounds of sufficient intensity and fluctuating noise levels above 35-45 decibels have been shown to alter the sleep pattern to lighter sleep and hence poorer sleep. Research indicates that when people are exposed to a great deal of noise they will complain of sleep loss and suffer a reduction of their feeling of well being. Regular interruptions of sleep by noise may prove a health hazard both physically and mentally. Figure 12 shows the results of a Canadian study of noise-induced sleep disturbance.

The EPA Task Group, in considering the effects of noise on sleep, has stated:

> "The maximum permissible outdoor level of L_{dn}=60 dB, proposed (below) in order to limit people's annoyance due to noise, would provide average sound levels from exterior noise sources below 35 dB at night in an average bedroom with closed windows. The levels in a bedroom with open windows could, of course, be higher but it is reasonable to expect that people who open their windows at night to be able to accommodate to slightly higher levels."
>
> "Experience has shown that, for typical traffic, airport and city noises, when the day/night difference in the equivalent noise level is 10 dB or more, the daytime exposure is the main concern with respect to potential speech interference and annoyance. In these situations, a maximum permissible outdoor L_{dn} of 60 dB, will generally cause negligible speech interference or annoyance during daytime, and will most likely cause no adverse effects on nighttime sleep in normal people accustomed to the environment, even with windows partially open."

F. Stress Effects of Noise

At noise levels of 85 decibels or more human stress reactions can be expected. When the brain perceives noise, it reacts. Most of us automatically interpret unexpected noise as danger, a signal to prepare to fight or run. It may be a subconscious reaction, but it is clearly indicated by the physical changes that take place in response to noise. Even a sound of moderate volume and short duration such as a heavy truck passing on the other side of the street (rated about 80 decibels), produces a remarkable number of these physical changes. Blood vessels in the brain dilate while blood vessels in other parts of the body constrict.

Blood pressure rises and the heart rhythm changes. The pupils of the eyes dilate. The blood cholesterol level rises. Various endocrine glands pour additional hormones into the blood. Even the stomach changes its rate of acid secretion. While most of these reactions are only temporary, the modern environment presents such ever-changing noise levels that some of these "temporary" effects become chronic.

We may not be immediately aware of these changes since they are functions of the so-called involuntary or autonomic nervous system. Yet this dramatic reaction to noise occurs in our bodies many times each day as we encounter the clamor of modern Twentieth-century living. Traffic, machinery, household appliances, lawnmowers, telephones, typewriters, barking dogs and shouting people all contribute. The effect on each of us can be profound.

Ulcers, indigestion, "heartburn", gastro-intestinal malfunctions, heart disease, all are connected to stress in general and since noise is interpreted by the body as a stress, noise may also be a contributing factor in the rate of occurrence of these disease conditions.

G. Psychological Effects

Stress also is a factor in mental illness, which may be defined as a reaction to a person's inability to cope with the many tensions of daily living. Mental illness develops when individuals are literally overwhelmed by the onslaught of stress and mentally retreat to escape. While environmental noise alone probably does not produce mental illness, the continual bombardment of noise on an already depressed person cannot be helpful. Certainly it interferes with sleep, producing irritability and other tensions. Definitive research has not been done in this area, but one 1969 study in England provides strong supporting evidence. Comparative studies of persons living adjacent to London's Heathrow Airport with others living in a quieter environment revealed that among those living in the noisy environment there was a significantly higher rate of admission to mental hospitals.

Another recent medical discovery is the effect of noise on unborn babies. Previously they were thought to be insulated from the noise stress of the outside world, but now physicians believe that external noises can and do trigger changes in fetuses.

Even when we do not suffer from these extreme and tragic consequences, we are victims of noise. It is well known that noise causes headaches in a variety of ways. Beause the brain interprets it as a danger signal, noise interrupts thought and mental concentration. This, in turn, not only lowers the working efficiency of people doing exacting or predominantly mental work, but the constant distraction of noise makes them more nervous, irritable and generally unsettled. It affects others in a similar manner. One study of steelworkers indicates that those working in a noisy environment are more aggressive, distrustful and irritable than workers in a quieter environment.

H. Noise Annoyance

An effect of noise on people which may include some of those symptoms discussed above is annoyance. It is a general term for describing the adverse response of people to noise. The EPA Task Group reviewed several studies on the annoyance of people caused by different noise levels, both for airports and other community noise sources. These studies showed an almost identical relationship between noise levels and percentage of people annoyed.

With the wide disparity between the percent annoyed and the percent complaining, it can be seen that the number of complaints is not an adequate measure of the effects of noise on people. The EPA Task Group recommends a maximum permissible average day-night sound level of 55 to 60 dB as the long range goal to protect the public's health and welfare.

The Task Group states:

> "An outdoor L_{dn} of approximately 60 dB or less is required in order that no more than 23% of the population exposed to noise would be individually highly annoyed (The same average sound level would guarantee that, on the average, 95% effective speech conversation at two meters distance outdoors would be possible at all times, and normal domestic speech activites are possible indoors, with open windows). It therefore appears reasonable to propose an L_{dn} of 55 to 60 dB as the long range goal for maximum permissible average sound level with respect to health and welfare. (Note that this level is not considered optimum, merely the upper limit of permissibility. No endorsement is intended of degradation of existing areas having a lower noise level").

Table 5 summarizes the maximum noise levels recommended by EPA Task Group 3.

I. Compatible Land Uses in Airport Noise Zones

The U.S. Department of Housing and Urban Development (HUD) has commissioned the preparation of guidelines for the compatibility of different land uses in noise zones around airports. These guidelines were prepared by the firm of Wilsey and Ham and are based on noise sensitivity factors for each type of land use.* The sensitivity factors are:

1. Speech communication needs,
2. Subjective judgements of noise acceptibility and relative noisiness by people living near airports,
3. Need for freedom from noise intrusions, and
4. Sleep sensitivity criteria.

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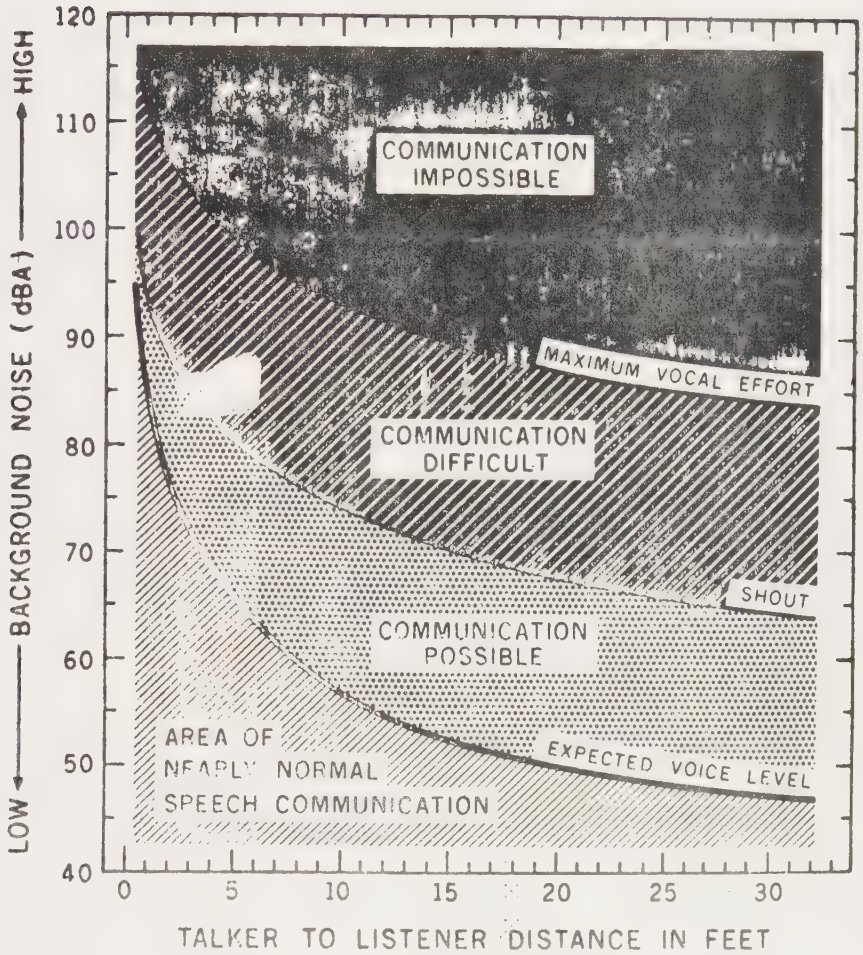
* Aircraft Noise Impact, Planning Guidelines for Local Agencies, U.S. Dept. of Housing and Urban Development, November, 1972.

FIGURE 11

CONVERSATION INTERFERENCE FROM NOISE



SOURCE: Effects of Noise on People, December 3, 1971, U.S. Environmental Protection Agency, p. 50.

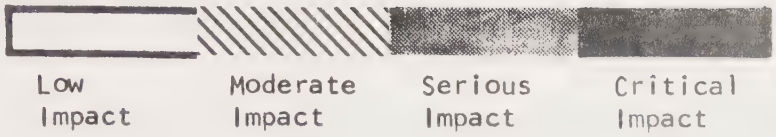
TABLE 5 RECOMMENDED MAXIMUM OUTDOOR NOISE LEVELS	
To prevent hearing damage	80 Decibels, L_{dn} *
For conversation	63
For sleeping	60
To prevent annoyance	60
* Day-Night average sound level.	

Source: EPA Noise Task Group 3.

Wilsey and Ham prepared a list of human activities, and based on research which has been done on the effects of noise on these activities, analyzed the degree of impact of different airport noise levels on each activity. The results of this analysis are shown in Figure. Next, land use categories were matched with the human activities which take place in each and the relative importance of each activity to each landuse type was determined. This is shown in Figure 14.

Finally, the guidelines were compiled by assigning noise sensitivity weights to each landuse based on the sensitivity of the human activities which are associated with each land use category. The guidelines are shown in Figure 15. The land use categories in Figure 16 vary in noise sensitivity from residential, which is rated 1, to public righ-of-way, which is rated 5. The acceptability categories (clearly acceptable, normally acceptable, normally unacceptable, and clearly unacceptable) indicate the suitability for new construction or development for each land use. These guidelines are intended as refinements of the less precise guidelines which were promulgated by HUD in August, 1971 in HUD Circular 1390.2

FIGURE 13
NOISE IMPACT ON HUMAN ACTIVITIES



Low Impact: Activity can be performed with little or no interruption from aircraft noise, though noise may be noticeable above background levels.

Moderate impact: Activity can be performed but with some interference from aircraft noise due to level or frequency of interruptions.

Serious impact: Activity can be performed but only with difficulty in the aircraft noise environment due to level or frequency of interruptions.

Critical impact: Activity cannot be performed acceptably in the aircraft noise environment.

Impact estimates based on activity criteria of Figure 2-16 and methodology developed in Figures 2-18, 2-19 and 2-20, for noise environment with 64 day and 8 night operations.

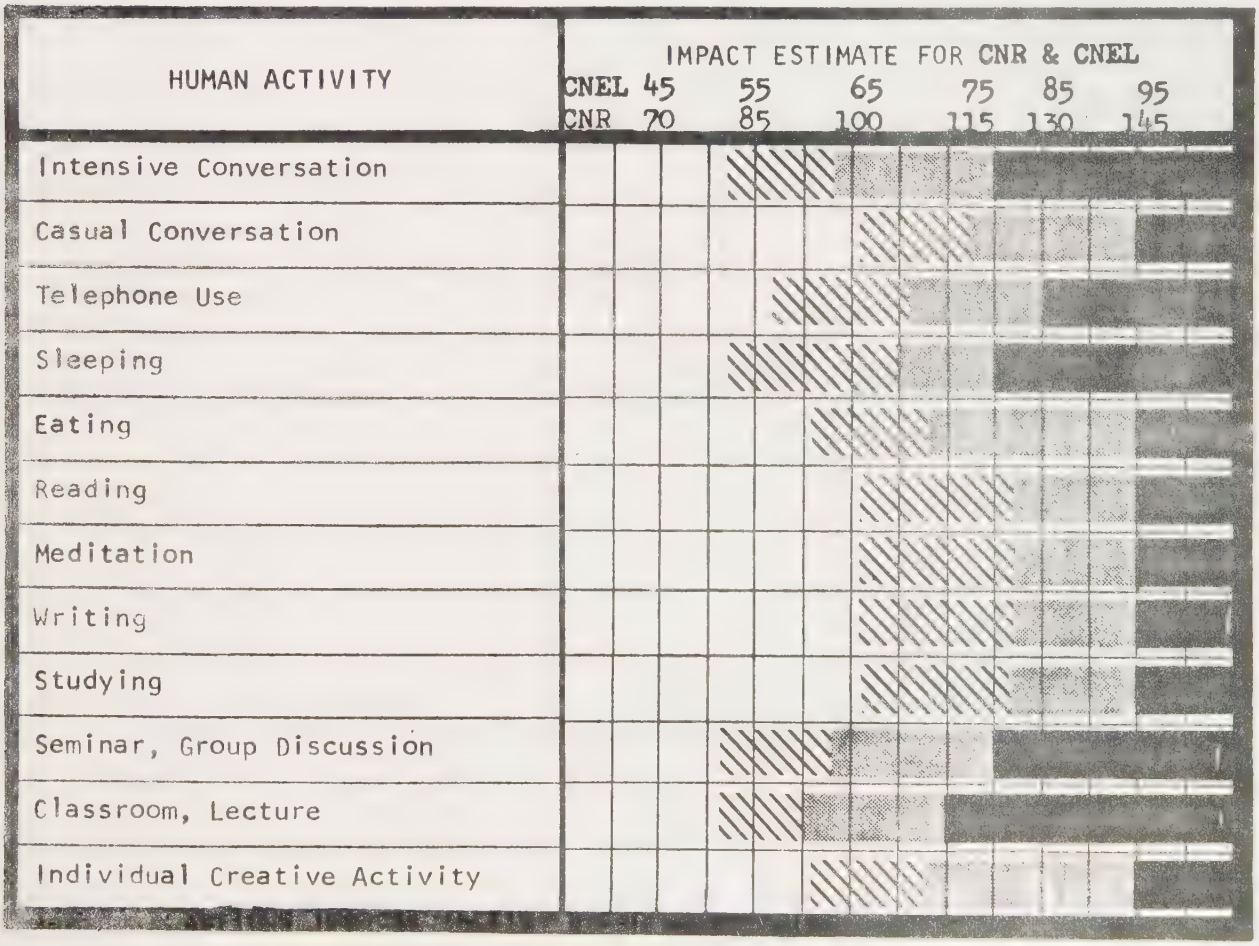
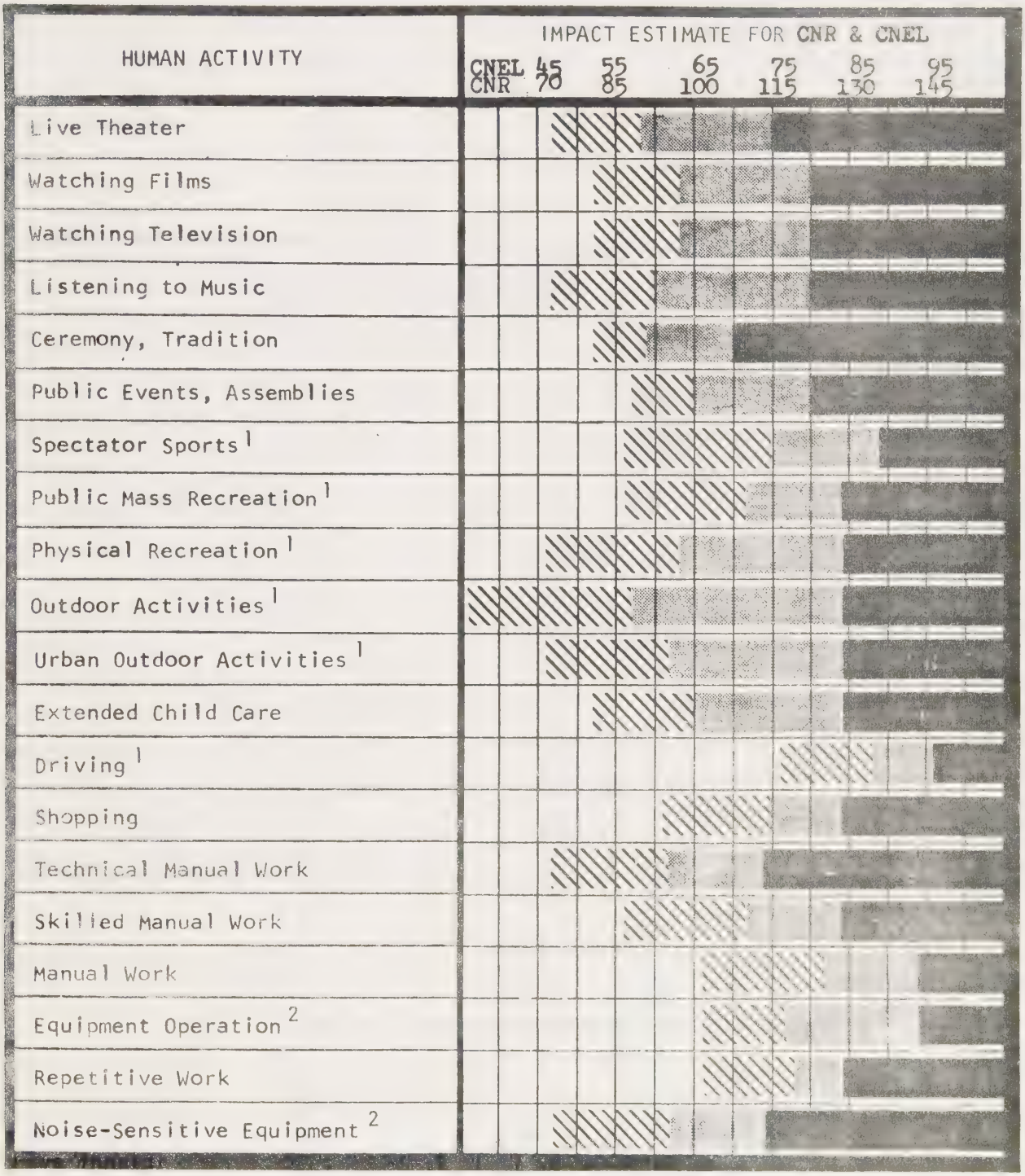


FIGURE 13 (Cont.)
NOISE IMPACT ON HUMAN ACTIVITIES



[1] No allowance for structural insulation.

[2] Depends on characteristics of particular equipment.

FIGURE 14
ACTIVITIES ASSOCIATED WITH[4] COMMON LAND USE CATEGORIES

LAND USE CATEGORY / HUMAN ACTIVITIES	SLUCM[1] CODE	Intensive Conversation	Casual Conversation	Telephone Use	Sleeping	Eating	Reading	Meditation	Writing	Studying	Seminar, Group Discussion	Classroom, Lecture	Individual Creative Activity	Live Theater	Watching Films	Watching Television	Listening to Music	Ceremony, Tradition	Public Events, Assemblies	Spectator Sports	Public Mass Recreation	Physical Recreation	Outdoor Activities	Urban Outdoor Activities	Extended Child Care	Driving	Shopping	Technical Manual Work	Skilled Manual Work	Manual Work	Equipment Operation	Noise-Sensitive Equipment
Residential - Single Family, Duplex	11x[2]	M	M	M	H	H	M	M	M	M	M	L	H	L	L	H	M	H	L	L	L	M	M	H	H	L	L	L	M	M	L	L
Residential - Mobile Homes	14	M	M	M	H	H	M	M	M	M	M	L	H	L	L	H	M	H	L	L	L	M	L	H	H	L	L	L	M	M	L	L
Residential - Multiple Family, Dormitories, etc.	11x, 12, 13, 19	M	M	M	H	H	M	M	M	M	M	L	H	L	L	H	M	H	L	L	L	M	L	H	H	L	L	L	M	M	L	L
Transient Lodging	15	L	M	M	H	H	M	M	L	M	M	L	L	L	L	H	M	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L
School classrooms, Libraries, Churches	68 7111	M	M	M	L	L	H	M	H	H	H	H	H	L	L	M	M	H	H	L	L	M	L	H	H	L	L	L	M	M	L	L
Hospitals, Nursing Homes	651	M	M	M	H	H	M	M	L	L	M	L	M	M	L	M	M	L	L	L	L	M	L	M	H	L	L	H	M	M	L	M
Auditoriums, Concert Halls, Music Shells	721	L	M	L	L	L	L	L	L	L	L	H	L	L	M	L	H	L	H	H	H	L	L	L	L	L	L	L	L	L	L	H
Sports Arenas, Outdoor Spectator Sports	722	L	M	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L	H
Playgrounds, Neighborhood Parks	761, 762	L	M	L	L	L	M	M	L	L	M	L	M	L	L	L	L	L	M	L	M	M	M	H	H	L	L	L	L	L	L	L
Golf Courses, Riding Stables, Water Rec., Cemeteries	741x, 743x, 744	L	M	L	L	L	L	M	L	L	L	L	L	M	L	L	L	L	L	L	L	H	M	H	L	L	L	L	L	L	L	L
Office Buildings, Personal, Business and Professional	61, 62, 63, 69, 65[3]	M	M	M	L	L	L	L	M	L	H	M	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	M
Commercial - Retail, Movie Theaters, Restaurants	53, 54, 56, 57, 59	M	M	L	L	H	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	H	L	L	M	L	L
Commercial - Wholesale, Some Retail, Ind., Mfg., Util.	51, 52, 64, 2, 3, 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	H	H	H	M
Manufacturing, Communications (Noise Sensitive)	35, 47	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	M
Livestock Farming, Animal Breeding	815, 816, 817	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L
Agriculture (except Livestock), Mining, Fishing	81, 82, 83, 84, 85, 91, 93	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L
Public Right-of-Way	45	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	H	L	L	L	L	H	L
Extensive Natural Recreation Areas	91, 92, 93, 99, 7491, 75	L	L	L	H	H	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	M	L	H	L	L	L	L	L	L

H: Activity critical to normal function of land use.

M: Activity important to normal function of land use.

L: Activity of secondary importance - land use generally able to function satisfactorily if activity cannot be performed.

[1] Standard Land Use Coding Manual.

[2] "x" represents a SLUCM category narrower or broader than, but generally inclusive of, the category described.

[3] Except hospitals.

[4] Matrix is intended as a guide to assist local planners in establishing a similar table for their particular community and land use classification system.

FIGURE 15
LAND USE COMPATIBILITY GUIDELINES FOR
AIRCRAFT NOISE ENVIRONMENTS

LAND USE INTERPRETATION

LAND USE CATEGORY	SLUCM[1] CODE	NSC[2]
Residential - Single Family, Duplex, Mobile Homes	11x[3]	1
Residential - Multiple Family, Dormitories, etc.	11x, 12, 13, 19	1
Transient Lodging	15	2
School classrooms, Libraries, Churches	68 7111	1
Hospitals, Nursing Homes	651	1
Auditoriums, Concert Halls. Music Shells	721	1
Sports Arenas, Outdoor Spectator Sports	722	1
Playgrounds, Neighborhood Parks	761, 762	1
Golf Courses, Riding Stables, Water Rec., Cemeteries	741x, 743x, 744	2
Office Buildings, Personal, Business and Professional	61, 62, 63, 69, 65[4]	3
Commercial - Retail, Movie Theaters, Restaurants	53, 54, 56, 57, 59	3
Commercial - Wholesale, Some Retail, Ind., Mfg., Util.	51, 52, 64, 2, 3, 4	4
Manufacturing, Communications (Noise Sensitive)	35, 47	2
Livestock Farming, Animal Breeding	815, 816, 817	3
Agriculture (except Livestock), Mining, Fishing	81, 82, 83, 84,85,91,93	5
Public Right-of-Way	45	5
Extensive Natural Recreation Areas	91, 92, 93, 99,7491,75	3

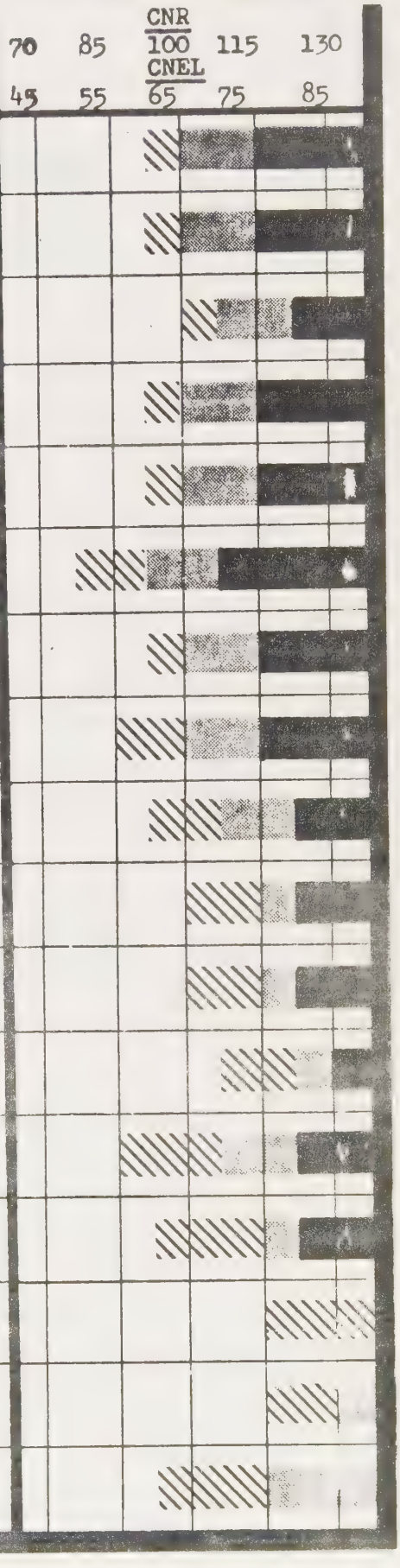


FIGURE 15

NOTES FOR FIGURE 15

Clearly Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable

Clearly acceptable: The noise exposure is such that the activities associated with the land use may be carried out with essentially no interference from aircraft noise. (Residential areas: both indoor and outdoor noise environments are pleasant.)

Normally acceptable: The noise exposure is great enough to be of some concern, but common building constructions will make the indoor environment acceptable, even for sleeping quarters. (Residential areas: the outdoor environment will be reasonably pleasant for recreation and play.)

Normally unacceptable: The noise exposure is significantly more severe so that unusual and costly building constructions are necessary to ensure adequate performance of activities. (Residential areas: barriers must be erected between the site and prominent noise sources to make the outdoor environment tolerable.)

Clearly unacceptable: The noise exposure at the site is so severe that construction costs to make the indoor environment acceptable for performance of activities would be prohibitive. (Residential areas: the outdoor environment would be intolerable for normal residential use.)

[1] Standard Land Use Coding Manual.

[2] Noise Sensitivity Code

[3] x represents SLUCM category broader or narrower than, but generally inclusive of, the category described.

[4] Excluding hospitals.

IDENTIFIED LEVELS OF ENVIRONMENTAL NOISE IN DEFINED AREAS

IDENTIFIED LEVELS

Table 6 identifies the levels requisite to protect public health and welfare with an adequate margin of safety for both activity interference and hearing loss. The table classifies the various areas according to the primary activities that are most likely to occur in each. The following is a brief description of each classification and a discussion of the basis for the identified levels in Table 6. For a more detailed discussion of hearing loss and activity interference, see Appendices C and D.

1. Residential areas are areas where human beings live, including apartments, seasonal residences, and mobile homes, as well as year-round residences. A quiet environment is necessary in both urban and rural residential areas in order to prevent activity interference and annoyance, and to permit the hearing mechanism to recuperate if it is exposed to higher levels of noise during other periods of the day.

   An indoor L_{dn} of 45 dB will permit speech communication in the home, while an outdoor L_{dn} not exceeding 55 dB will permit normal speech communication at approximately three meters. Maintenance of this identified outdoor level will provide an indoor L_{dn} of approximately 40 dB with windows partly open for ventilation. The nighttime portion of this L_{dn} will be approximately 32 dB, which should in most cases, protect against sleep interference. An $L_{eq(24)}$ of 70 dB is identified as protecting against damage to hearing.

   Although there is a separate category for commercial areas, commercial living accommodations such as hotels, motelsm cottages, and inns should be included in the residential category since these are places where people sleep and sometimes spend extended periods of time.

2. Commercial areas include retail and financial service facilities, offices, and miscellaneous commercial services. They do not include warehouses, manufacturing plants, and other industrial facilities, which are included in the industrial classification. Al though a level for activity interference has not been identified here (see footnote a), suggestions for such levels will be found in Table D-10 of Appendix D. On the other hand, a level of $L_{eq(24)}$ of 70 dB has been identified to protect against hearing loss.

3. Transportation facilities are included so as to protect individuals using public and private transportation. Included within this classification are commercial and private transportation vehicles. Identification of a level to protect against hearing loss is the only criterion used at this time, although levels lower than an L_{eq} of

Table 6

YEARLY AVERAGE*EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

	Measure	Indoor Activity Interference	Indoor Hearing Loss Consideration	Indoor To Protect Against Both Effects (b)	Outdoor Activity Interference	Outdoor Hearing Loss Consideration	Outdoor To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)}$(d)	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)}$(d)		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity. (See Figure D-2 for noise levels as a function of distance which allow satisfactory communication.)
b. Based on lowest level.
c. Based only on hearing loss.
d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average. i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years.

*Refers to energy rather than arithmetic averages.

70 dB are often desirable for effective speech communication. However, because of the great variety of conditions inside transportation vehicles, and because of the desirability of speech privacy in certain situations, a level based on activity interference cannot be identified for all modes of transportation at this time.

4. Industrial areas include such facilities as manufacturing plants, warehouses, storage areas, distribution facilities, and mining operation. Only a level for hearing loss is identified due to the lack of data with respect to annoyance and activity interference. Where the noise exposure is intermittent, an $L_{eq}(24)$ of 70 dB is identified as the maximum level for protection of hearing from industrial exposure to intermittent noise. For 8-hour exposures, an $L_{eq}(8)$ of 75 dB if considered appropriate so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average.

5. Hospital areas include the immediate neighborhood of the hospital as well as its interior. A quiet environment is required in hospital areas because of the importance of sleep and adequate rest to the recovery of patients. The maintenance of a noise level not exceeding an L_{dn} of 45 dB in the indoor hospital environment is deemed adequate to prevent activity interference and annoyance. An outdoor L_{dn} of 55 dB should be adequate to protect patients who spend some time outside, as well as insuring an adequately protective indoor level. An $L_{eq}(24)$ of 70 dB is identified to prevent hearing loss.

6. Educational areas include classrooms, auditoriums, schools in general, and those grounds not used for athletics. The principal consideration in the education environment is the prevention of interference with activities, particularly speech communication. An indoor noise level not exceeding $L_{eq}(24)$ of 45 dB is identified as adequate to facilitate thought and communication. Since teaching is occasionally conducted outside the classroom, an outdoor $L_{eq}(24)$ of 55 dB is identified as the maximum level to prevent activity interference. To protect against hearing loss an $L_{eq}(24)$ of 70 dB is identified for both indoor and outdoor environments. As in the industrial situation, eight hours is generally the amount of time spent in educational facilities. Therefore an $L_{eq}(8)$ of 75 dB is considered appropriate to protect against hearing loss, so long as the exposure over the remaining 16 hours is low enough to result in a negligible contribution to the 24-hour average.

7. Recreational areas include facilities where noise exposure is voluntary. Included within this classification are nightclubs, theaters, stadiums, racetracks, beaches, amusement parks, and athletic fields. Since sound exposure in such areas is usually voluntary, there is seldom any interference with the desired activity. Consequently, the chief consideration is the protection of hearing. An $L_{eq}(24)$ of 70 dB is therefore identified for intermittent noise in order to prevent hearing damage.

8. Farm and general unpopulated land primarily includes agricultural property used for the production of crops or livestock. For such areas, the primary considerations are the protection of human hearing and the prevention of adverse effects on domestic and wild animals. Protection of hearing requires that an individual's exposure to intermittent noise does not exceed $L_{eq(24)}$ of 70 dB. A separate level for the exposure of animals is not identified due to the lack of data indicating that hearing damage risk for animals is substantially different from that of humans. The unpopulated areas include wilderness areas, parks, game refuges, and other areas that are set aside to provide enjoyment of the outdoors. Although quiet is not always of paramount importance in such areas, many individuals enjoy the special qualities of serenity and tranquility found in natural areas. At this time it is not possible to identify an appropriate level to prevent activity interference and annoyance. However, when it becomes possible to set such a level, a clear distinction should be made between natural and man-made noise.

USE OF IDENTIFIED ENVIRONMENTAL NOISE LEVELS

One of the purposes of this document is to provide a basis for judgement by states and local governments as a basis for setting standards. In doing so the information contained in this document must be utilized along with other relevant factors. These factors include the balance between costs and benefits associated with setting standards at particular noise levels, the nature of the existing or projectted noise problems in any particular area, the local aspirations and the means available to control environmental noise.

In order to bring these factors together, states, local governments and the public will need to evaluate in a systematic manner the following.

1. The magnitude of existing or projected noise environments in defined areas as compared with the various levels identified in this document.

2. The community expectations for noise abatement with respect to existing or projected conditions.

3. The affected elements of the public and the degree of impact of present or projected environmental noise levels.

4. The noise sources, not controlled by Federal regulations, that cause local noise problems.

5. Methods available to attack environmental noise problems (use limitations, source control through noise emission standards, compatible land use planning, etc.).

6. The costs inherent in reducing noise to certain levels and benefits achieved by doing so.

7. The availability of technology to achieve the desired noise reduction.

The levels of environmental noise identified in this report provide the basis for assessing the effectiveness of any noise abatement program. These noise levels are identified irrespective of the nature of any individual noise source. One of the primary purposes of identifying environmental noise levels is to provide a basis by which noise source emission regulations, human exposure standards, land use planning, zoning, and building codes may be assessed, as to the degree with which they protect the public health and welfare with respect to noise. Such regulatory action must consider technical feasibility and economic reasonableness, the scale of time over which results can be expected, and the specific problems of enforcement. In the process of balancing these conflicting elements, the public health and welfare consequence of any specific decision can be determined by comparing the resultant noise environment against the environmental noise levels identified in this report.

APPENDIX D

Description and Evaluation of Existing Noise Control Regulations with Recommendation:

Several different types of existing regulations were reviewed in an attempt to evaluate and determine the status of local noise control regulations in California. These regulations were grouped into one of four classes employing guidelines used by the federal government to classify the effectiveness of existing city noise control ordinances. The guidelines enable classification of noise ordinances into Classes A through D where A type ordinances are considered the most effective and D type is least effective.

1. Class D Type Noise Control Regulations:

   Class D regulations contain little or no reference to noise control. This type of noise control regulation utilizes language which generally indicates that no person shall create a public nuisance or disturb the peace.

   A typical example of a Class D type noise control regulation is Section 415 of the California State Penal Code.

   Class D type noise control regulations are not recommended for adoption because of the vagueness of the language and the anticipated difficulty in obtaining correction of noise problems.

2. Class C Type Noise Control Regulations:

   Class C regulations usually include the general body of a noise control statute and indicates in some manner that noise is a nuisance or as being prohibited. These regulations do not specify quantitative noise standards or enforcement techniques other than possibly the discretionary issuance of a ticket by a local enforcement agency. Class C regulations are only slightly different than Class D regulations.

   Class C type noise control regulations are not recommended for adoption because of the difficulty of enforcement due to inadequate definitions for such terms as "excessive noise", "unnecessary noise or sounds" and "annoying to persons of ordinary sensitivity". It is anticipated that Class C type noise control regulations would be difficult to enforce.

3. Class B Type Noise Control Regulations:

   Class B regulations contain some type of quantitative noise standard and also contains provision for measurement and enforcement.

   This type of noise control regulation specifies allowable noise limits in terms of an "A" weighted network (dBA), although there are other Class B type noise control regulations which utilize octave band frequencies for determining violations of a specific standard.

Class B type noise control regulations may be acceptable for adoption under certain conditions, however, they are not considered the best method to control noise and abate community noise problems.

One noise standard is applied throughout the entire city area under Class B type noise control regulations. The particular noise standard may not be appropriate to prevent complaints from residents or other occupied areas although the alleged source is creating noise within the legal limits. The ordinance is not tailored for different types of residential zoning conditions or based on actual existing noise levels normal for a specific area. Class B type noise control regulations therefor are not recommended for adoption.

4. Class A Type Noise Control Regulations:

Class A regulations have a higher degree of sophistication in statutory language relating to noise control than any of the other classes. This class may include different quantitative noise standards for various areas and land use zones. Class A regulations also include specific requirements for detailed measurement and specifies the enforcement technique. The development of various quantitative noise limits for an area or land use zone may be based on actual existing noise levels in the specific area. Certain areas and land use zones may be assigned significantly different noise limits.

An example of Class A type noise regulations are the ordinances currently in effect in the cities of Fountain Valley, Costa Mesa, Los Angeles and those proposed for adoption in Pasadena and Seal Beach, California as well as the ordinance recommended by the League of California Cities.

From the public health standpoint, it is not only necessary to abate periodic noise in a community but also to control if possible the growth of noise pollution. It is believed that a Class A type noise control regulations will enable abatement of most nuisance noise conditions and, if used as a planning tool, will assist in the development of residential and other landuse areas which are not subjected to irritating and nuisance noise conditions.

Although it is recognized that the adoption of a Class A type noise control regulation may not be the total answer to every noise problem or complaint, Class A regulations are the most effective.

APPENDIX E

ANALYSIS OF JURISDICTIONAL RESPONSIBILITY IN NOISE CONTROL

As federal, state and local governments become more responsive to environmental noise problems, confusion arises when different jurisdictions attempt to regulate the same sources of noise. In the Noise Control Act (NCA) of 1972 Congress recognized that, while the primary responsibility for control of noise rests with state and local governments, federal action is essential to deal with major noise sources in commerce which require national uniformity of treatment.

The Constitution vests in Congress the right to regulate interstate and foreign commerce, and thus the authority to regulate the noise associated with such commerce. The NCA provides for the establishment of federal noise emission standards for new products and requires that the noise emission and/or reduction characteristics of such products be printed on the new product labels. The Act also authorizes the Environmental Protection Agency (EPA) to establish noise emission standards for motor carriers engaged in interstate commerce, and to recommend regulations to the Federal Aviation Administration (FAA) which the EPA feels are necessary to regulate aircraft noise as well as coordinate federal research activity in noise control. State and local governments are prohibited from setting noise emission levels different from those promulgated by EPA for noise sources covered in the NCA. However, enforcement of noise standards to regulate the use, operation or movement of products and other noise sources whose control is not preempted by federal regulations.

FIGURE 16

Summary Analysis of Jurisdictional Responsibility in Noise Control

	AIRCRAFT	MOTOR VEHICLE	NOISE IN GENERAL
FEDERAL	- NCA 1972, EPA to propose noise control regulations for aircraft, amends S 611 FAA Act of 1958, asserts that FAA and EPA pre-empt local control (U.S.C. 1973)	- Federal Aid Highways Act, P.L. 91-605 directs Secretary of Transportation to make standards for highway noise control; promulgated in PPM 90-2 of February, 1973 - NCA 1972, regulates noise from surface carriers and motor vehicles engaged in interstate commerce.	- Walsh Healy Act applies noise standards to Fed. contracts. - O.S.H.A. applies noise standards to businesses affecting interstate commerce. - NCA 1972 gives EPA authority to prescribe standards for new products: + construction equipment + transportation equipment + any motor or engine + electric/electronic equipment als label noise emitting or noise abating equipment.
STATE (California)	-California Administrative Code Subchapter 6. Noise standards, Department of Aeronautics. Regulate noise for all aircraft operations to the extent not already limited by federal law.	- Motor Vehicle Code regulates noise limits for new vehicles and all motor vehicle operation. - Cal. Streets and Highways Code S 216 regulates noise within schools near freeways - Harbor and Navigation Code S2:654.05 regulates noise emission from motorboats in or upon inland waters.	- Division of Industrial Safety publishes noise regulations. - S 415 Penal Code prohibits loud and unusual noise that disturbs the peace. - Environmental Quality Act encourages local agencies to control environmental quality. - Administrative Code sets noise insu lation standards for hotels, etc.
LOCAL	- Airport authority as proprietor may impose curfew. (Issue has yet to be resolved in courts.)	- Local jurisdiction may enact regulations for off-highway motor vehicles, refuse vehicles and sound trucks. - May regulate the use of roads and highways based on noise considerations. - May enforce provisions of Motor Vehicle Code	- May enact ordinances to control: + construction noise + amplified sound + fixed noise sources + loud/unusual noise + other noise sources whose control is not pre-empted by state or federal government. - UBC,1973, sets noise insulation standards for dwelling interior walls.

FIGURE 17

LEGAL BASIS FOR AIRCRAFT NOISE JURISDICTION SUMMARY OUTLINE:	
(1)	United States Supreme Court, 1962, Griggs vs. Allegheny.
	(a) Airlines and federal government are not liable.
	(b) Proprietor is liable as promotor, owner and lessor.
(2)	S 611 amendment (1968) to FAA Act of 1958.
	- Federal government engaged in active program of noise abatement.
(3)	NCA of 1972 - amends Section 611 of FAA Act of 1958.
	(a) EPA in conjunction with FAA responsible for aircraft noise abatement.
	(b) Reasserts primary responsibility for control of noise rests with state and local governments, except the federal government preempts control of interstate commerce.
(4)	United States Supreme Court, 1973, Lockheed vs. Burbank.
	(a) EPA and FAA preempt state and local aircraft control.
	(b) Limits, if any, regarding proprietor's jurisdiction have yet to be decided.

In California the legislature has taken the initiative in both aircraft and motor vehicle noise control.* The state adopted the nation's first state aircraft noise abatement law as well as the first acoustical standards limiting truck, auto, and motorcycle noise.[16]

The League of California Cities and the California Conference of Directors of Environmental Health have developed model noise ordinances to serve as guides in the development of local noise ordinances. The models include provisions for special noise sources, construction noise, amplified sound, and enforcement; and contain references citing the legal basis and technical rationale for these provisions.

See Figure 11 for a summary analysis of jurisdictional responsibility in noise control.

A. Aircraft Noise

1. Federal

Aircraft noise is being reduced by the combined efforts of the Environmental Protection Agency (EPA), the Federal Aviation Administration (FAA), Federal Department of Transportation (DOT), jet engine manufacturers, the airlines and airport authorities. Solutions being sought include:[17]

1. Reduction of engine noise on new and old aircraft (FAR 36).
2. Instituting flight paths that affect the least number of people.
3. Instituting a takeoff and landing procedure that includes steep ascent and descent, to keep the aircraft at high altitudes over populated areas.
4. Require throttle cutbacks over highly sensitive areas.
5. Restrict the number of flights; especially at night.
6. Pass sensible zoning restrictions for land use near airports.
7. Re-locate airports far from cities, and improve ground transportation.

In response to the problems created by aircraft noise, the NCA requires EPA to conduct a study of:

1. The adequacy of FAA flight and operational noise controls.
2. The adequacy of present aircraft noise emission standards (including recommendations of retrofit).

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* The State Senate recently passed SB 1220, The California Noise Control Act of 1973, which establishes a State Office of Noise Control to provide technical assistance to local jurisdictions to help combat noise pollution. (California Health and Safety Code SS 39800 *et seq.*)

3. The implications of achieving levels of cumulative noise exposure around airports.

4. Additional measures available to airport operators and local governments to control noise.

In accordance with these provisions EPA recently submitted a report to Congress. In the report the administrator indicated the following proposals will be forthcoming:[18]

1. Regulations concerning flight and operational noise controls: The regulations will include options for takeoff procedures, approach and landing procedures and minimum flight altitudes.

2. Amendments to FAR Part 36 to specify lower noise levels for future aircraft.

3. Regulations to control and reduce the noise emissions from existing aircraft. The FAA's proposed Fleet Noise Level (FNL) methodology will be considered as a flexible means of promoting any of the source technology options (nacelle treatment, refan or aircraft replacement).

4. Cooperative actions to develop an airport noise certification regulation that will insure control over cumulative noise near airports.

The NCA required the EPA to submit to FAA recommendations for regulations which EPA feels are necessary to protect the public health and welfare.

FAA retains the power to prescribe and amend aircraft noise measurement and noise emission regulations as authorized under Section 611 of the FAA Act of 1958. This is to insure that the regulations proposed by EPA will not interfere with aircraft safety. The Act outlines in detail the process for public dissemination of the information regarding the FAA's action on the EPA's recommendations.[19]

Under the FAA Act of 1958 the Civil Aeronautics Board (CAB) is directed to regulate the economic aspects of the airline industry. In addition, with the passage of the National Environmental Policy Act of 1970 CAB was given the authority to deny a certificate authorizing air transportation if it finds that the adverse impact on the environment outweighs whatever factors point to the grant of the certificate.

2. State

California Public Utilities Code (Section 21669 et. seq.) provides noise standards to protect the public from aircraft noise and to resolve the incompatibilities between airports and their neighbors. The regulations are applicable to operations of civilian aircraft and aircraft engines which produce noise, to the degree that such operations are not already

limited by federal law. The regulations serve as additions to remedies provided for by other laws are not intended to prevent local governments from setting more stringent standards.

The State requires each county to determine which of the airports within its boundaries are required to initiate aircraft monitoring in accordance with the state regulations. The county is responsible for validating the airport's noise monitoring, enforcing regulations and submitting quarterly reports to the State Department of Aeronautics including: a map of the noise impact boundary, daily CNEL measurements and the total number of recorded violations of the noise limits.[20]

State law finds that the area of land within the noise impact boundary is compatible with the following uses:[21]

1. Agricultural, airport industrial and commercial property.

2. Property subject to aviation easement for noise.

3. Zoned open space.

4. High-rise apartment with adequate insulation and central air conditioning.

5. Acoustically treated single-family homes (existing airports only).

Section 21670 et. seq. of the Public Utilities Code requires each county to form an Airport Land Use Commission responsible for formulating a comprehensive land use plan for all Airport Influence Areas.*

3. Legal Basis for Airport Regulation

The Supreme Court decision in Griggs vs. Allegheny County (1962) concluded that the airport proprietor must accept liability for injury from aircraft noise since it was the "promotor, owner and lessor of the airport." The airlines are not liable since they lease the right to land and take off from the proprietor. The Federal Government is not liable since takeoff and landing operations are not within the navigable air-space i.e., the public domain.[22]

It was not until the 1968 enactment of Section 611 (as an amendment to the FAA Act of 1958) relating to the Control of Aircraft Noise and Sonic Boom that the Federal Government was directly engaged in an active program of aircraft noise abatement.

The FAA Act of 1958, Section 611, was amended by the NCA which gives EPA the authority to regulate noise from aircraft engaged in commerce in conjunction with FAA. The NCA also asserts that the primary responsibility for control of noise rests with state and local governments.

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* Area adjacent to airport which is impacted by noise levels exceeding state noise standards.

The Supreme Court decision in Lockheed vs. Burbank (May 1973) concluded that "... the pervasive control vested in EPA and in FAA under the 1972 Act seems to us to leave no room for local curfews or other local controls. FAA now in conjunction with EPA, has full control over aircraft noise, preempting state and local control."

However, note was made in the same decision that "although it was ruled the local municipality was preempted by federal law where the airport was privately owned, this need not preclude a different ruling for those municipalities that are also the proprietor of the airport." "Federal law does not necessarily affect rights of a state or public agency as the proprietor of an airport from issuing regulations or establishing requirements as to the permissible level of noise which can be created by aircraft using the airport.... The federal government is in no position to require an airport to accept service by (1) larger aircraft and, for that purpose, to obtain longer runways, (2) noisier aircraft, and for that purpose to obtain longer runways, and (3) likewise, the federal government is in no position to require an airport to accept service by noisier aircraft, and for that purpose to obtain additional noise easements."[23]

The Supreme Court's decision was concerned with the exercise of the police power, but "the authority that a municipality may have as a landlord is not necessarily congruent with its police power. We do not consider here what limits, if any, apply to a municipality as proprietor." (USC, May 1973).

The federal government therefore has occupied a portion, but not the entire field of regulating aircraft-produced community noise. State and local governments can legislate noise controls if they are not in conflict with the federal statutes. However, while the FAA contends it has preempted the state in the area of aircraft noise control, California's Attorney General believes that this is not the case. (Attorney General Opinion No. 216; 2/27/70.) The courts have yet to rule on this issue.[24]

See Figure 12 for a summary of the legal basis for aircraft noise jurisdiction.

B. Motor Vehicle Noise

1. Federal

On the national level, the Federal Aid Highways Act was amended in 1970 by P. L. 91-605 directing the Secretary of Transportation to promulgate standards for highway noise levels compatible with different land uses and not to approve any location unless adequate noise control measures have been implemented. These standards were published in DOT Policy and Procedure Memorandum 90-2 on February 8, 1973.

The NCA requires that EPA, in consultation with the Department of Transportation, be responsible for making regulations to govern noise emission from the operation of surface carriers and motor vehicles engaged in

interstate commerce. State and local governments are prohibited from establishing noise emission limits different from the applicable federal standards unless the EPA administrator determines that local conditions necessitate different regulations.

Pursuant to Section 18 of the NCA, EPA published proposed noise emission regulations for motor carriers in the Federal Register on July 27, 1973. The report concludes that nearly all existing large trucks (three or more axles) can be retrofitted to achieve a noise level of 86 dB(A) under 35 mph, and also comply with a 90 dB(A) noise level at high speeds (the additional noise being due to the tires.)[25]

2. State

California's vehicle noise control program has consisted of the enforcement of maximum, new-vehicle noise emission standards and the regulation of vehicle operation. The state has the responsibility for setting noise emission standards for all motor vehicle subject to registration. The California Highway Patrol has the prime responsibility for enforcing these regulations. However, local police can also enforce them.[26] (See Table 5.)

Section 216 of the California Streets and Highways Code requires the State to reduce the noise levels from freeways in certain kinds of schools. The state measures the noise level produced by the traffic on a state freeway in the classrooms, libraries, and multi-purpose rooms of schools adjacent to the proposed right-of-way prior to the adoption of the particular freeway route. If the noise level generated by normal traffic exceeds the standards of this section, the state is responsible for noise abatement in the affected rooms.

Any motorboat in inland waters shall conform to the noise levels set within Section 2:654.05 of the California Harbor and Navigation Code, with the exception of those motorboats in a race or regatta when authorized by a permit issued by the local authority having jurisdiction over the area. (See Table 6.)

3. Local

As a general rule a city or county may make and enforce within its limits police power ordinances not in conflict with the general laws (Section VII, Article XI of the California Constitution). However, the right to control street traffic is an exercise of the sovereign power of the state. Thus, cities and counties may not enact noise limits to be enforceable <u>on highways</u>. (See Table 7.)

Local jurisdictions may, however, enact <u>off-highway</u> vehicular noise limits when directed at the operator. They may also designate quiet zones by banning noisy vehicles from certain streets, highways, or freeways. The state retains the authority to require off-highway vehicles to be equipped with an adequate muffler that meets the requirements of Section 38275 and 38280 of the Motor Vehicle Code. Local jursidictions

TABLE 7

NOISE LIMITS FOR NEW MOTOR VEHICLES
STATE OF CALIFORNIA

S27160. (a) No person shall sell or offer for sale a new motor vehicle which produces a maximum noise exceeding the following noise limit at a distance of 50 feet from the centerline of travel under test procedures established by the department:

(1) Any motorcycle manufactured before 1970	92 dbA
(2) Any motorcycle, other than a motor-driven cycle, manufactured after 1969, and before 1973	88 dbA
(3) Any motorcycle, other than a motor-driven cycle, manufactured after 1972, and before 1975	86 dbA
(4) Any motorcycle, other than a motor-driven cycle, manufactured after 1974, and before 1978	80 dbA
(5) Any motorcycle, other than a motor-driven cycle, manufactured after 1977, and before 1988	75 dbA
(6) Any motorcycle, other than a motor-driven cycle, manufactured after 1987	70 dbA
(7) Any snowmobile manufactured on or after January 1, 1973, and before January 1, 1975	82 dbA
(8) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured after 1967, and before 1973	88 dbA
(9) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured after 1972, and before 1975	86 dbA
(10) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured after 1974, and before 1978	83 dbA
(11) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured after 1977, and before 1988	80 dbA
(12) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured after 1987	70 dbA
(13) Any other motor vehicle manufactured after 1967, and before 1973	86 dbA
(14) Any other motor vehicle manufactured after 1972, and before 1975	84 dbA
(15) Any other motor vehicle manufactured after 1974, and before 1978	80 dbA
(16) Any other motor vehicle manufactured after 1977, and before 1988	75 dbA
(17) Any other motor vehicle manufactured after 1987	70 dbA

SOURCE: Section 27160, Motor Vehicle Code

TABLE 8

NOISE LIMITS FOR NEW OFF HIGHWAY MOTOR VEHICLES

STATE OF CALIFORNIA

(1)	Any such vehicle manufactured on or after January 1, 1972, and before January 1, 1973	92 dBA
(2)	Any such vehicle manufactured on or after January 1, 1973, and before January 1, 1975	88 dBA
(3)	Any such vehicle manufactured on or after January 1, 1975.	86 dBA

Source: Section 38280, Motor Vehicle Code

TABLE 9

NOISE LIMITS FOR ON HIGHWAY MOTOR VEHICLES

STATE OF CALIFORNIA

	On Streets with a Grade of 1% or higher		On Streets with a Grade not exceeding 1%
	Speed Limit of 35 mph or less	Speed Limit of more than 35 mph	Speed Limit of 35 mph or less
(1) Any motor vehicle with a manufacturer's gross vehicle weight rating of 6,000 pounds or more and any combination of vehicles towed by such motor vehicle:			
(a) Before January 1, 1973	88 dB(A)	90 dB (A)	-
(b) On and after January 1, 1973	86 dB(A)	90 dB (A)	82 dB(A)
(2) Any motorcycle other than a motor-driven cycle	82 dB(A)	86 dB (A)	77 dB(A)
(3) Any other motor vehicle and any combination of vehicles towed by such motor vehicle	76 dB(A)	82 dB (A)	74 dB (A)

SOURCE: Section 23130, 23130.5, Motor Vehicle Code

may enforce the provisions of the Motor Vehicle Code through their Police or Sheriff's Departments, as is the case in the City/County of San Francisco.

C. General Noise Sources

1. Federal

Industrial noise levels that cause hearing loss are prohibited by the Walsh-Healy Public Contracts Act and the National Occupational Safety and Health Act (OSHA). These acts set a maximum allowable exposure time of eight hours for noise levels above 90 dB(A), a level at which you must shout in order to be heard just two feet away. The Walsh-Healy Act applies the limits to contractors supplying the federal government with materials, supplies, articles or equipment under contracts in excess of $10,000. The OSHA is applicable to all businesses which are engaged in interstate commerce. In neither case do these acts preempt state or local governments.[27]

Another federal noise regulation is contained in the Department of Housing and Urban Development (HUD) Circular 1390.2, which establishes noise exposure policies and standards to be used in the approval or disapproval of all HUD assisted projects. The authority for this circular is based on Section 102(2)(c) of the National Environmental Policy Act of 1969.

The NCA gives the EPA authority to prescribe standards limiting the noise generating characteristics for any product or class of products which has been identified as a major source of noise and which falls in the following categories:

- Construction equipment
- Transportation equipment (including recreational vehicles)
- Any motor or engine
- Electrical or electronic equipment

The standards for these products must be based on those set by research study reports and maximum noise levels which are necessary to protect the public health or welfare. Furthermore, EPA must require the manufacturer of any product whose noise emission may adversely affect the public health or welfare, or which is sold on the basis of its effectiveness in reducing noise to the consumer. In no instance can state or local governments set noise standards different from those set by the EPA, unless such standards regulate the use, operation or movement of products (as opposed to their manufacture).

2. State

In California, Section 21001 of the California Environmental Quality Act declares that it is the policy of the state to require governmental agencies

at all levels to develop standards and procedures necessary to provide the people of California freedom from excessive noise. Section 39800 et. seq. of the California Health and Safety Code established a State Office of Noise Control to provide technical assistance to local jursidictions to help combat noise pollution.

The control of industrial noise remains within the authority of the State Division of Industrial Safety which is responsible for enforcing the noise abatement regulations in Section 5095 et. seq. of the California Administrative Code.

Section 415 of the California Penal Code prohibits disturbing the peace by any loud or unusual noise. Section 65302(g) of the California Government Code requires a noise element in all city and county general plans.

Section 1092 of the California Administrative Code establishes minimum noise insulation performance standards for motels, hotels, and other multiple-occupancy dwellings. Interior noise standards are expressed in terms of CNEL levels and require acoustical analyses when residential structures, as defined, are located within a CNEL 60 contour of airports, transportation routes, and industrial areas.

3. Local

Local jursidictions may enact noise regulations to secure and promote the public health, and welfare as an exercise of their police power as long as they are not in conflict with general laws (Section VII, Article XI of the California State Constitution).

a. Loud and Unusual Noises

The prohibition of unnecessary, excessive and annoying noises falls within the jurisdiction of the local authority which may declare such noises illegal by ordinance. These may include:

- Horns and signaling devices on private property
- Drums
- Animals and Fowls
- Steam whistles
- Engines in non-moving motor vehicles

At present such noises cannot effectively be controlled by decibel standards and are best handled by disturbing-the-peace ordinances. The lack of objective criteria for nuisances of this type plus a lack of sufficient around-the-clock enforcement limit the alternatives.

b. Construction Noises

The EPA is responsible for requiring that manufacturers limit the noise-generating characteristics of the construction equipment they produce to fit EPA standards. A local authority may place a curfew on construction that creates unnecessary, offensive or excessive noise as well as restrict the use of construction equipment that breaks quantitative acoustical standards in a noise ordinance.[28]

c. Other Noise Regulations

The local authority may enact standards limiting noise emissions which cross property lines. The use of property may be required to conform with the performance standards stated in a noise ordinance. These performance standards are meant to apply to noise-generating apparatus or activities within a particular area and are not to be confused with the new product standards of EPA. License and permit type provisions may be used to limit or require compliance with performance standards as a condition to the installation or operation of equipment. In addition, curfews may be set to prohibit certain noise-generating activities during a specified time interval, usually at night.[29]

Zoning provisions may also be adopted to determine the relative compatibility of a particular land use to the noise. For example, land use for manufacturing would be compatible where noise levels are considered excessive, while residential land use would be incompatible with excessive noise.[30]

The 1973 Uniform Building Code, if adopted by local agencies, requires interior walls and floor-ceiling assemblies in residential dwellings to meet specific noise insulation performance standards, Field or laboratory testing may be accepted without additional field testing when the tested design has not been compromised by flanking paths. Field testing, when required, must be done under the supervision of a professional acoustician.

Local agencies are also responsible for enforcing Section 1092 of the California Administrative Code, Title 25, which establishes noise insulation requirements for multiple-occupancy dwellings. They are also empowered to adopt a local ordinance with similar requirements for single-family dwellings.